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TRAUMATIC SHOCK—A CONSIDERATION OF SEVERAL TYPES OF INJURIES

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IN all types of diseases and injuries the ideals to be sought for are early diagnosis and effective therapy. A number of factors militate against the accomplishment of these objectives in dealing with the conglomeration of abnormalities which are grouped together under the term shock. Even those instances of failure of the peripheral circulation about which we know a great deal, such as that which may follow simple hemorrhage, become complicated when considered together with many other types, some of which may have no relation whatever to each other. It might be wise if the word "shock" could be abolished, but common usage makes this impossible at the present time. Since the word will probably be retained, it would be helpful if a descriptive term could be used with it such as shock following hemorrhage, shock following burns, shock following trauma to large masses of muscle, shock following crush injuries, postoperative shock, and so forth.

Many efforts have been made to find a uniform means of diagnosing early or incipient shock. Again, the problem is complicated by the all-inclusive use of the word shock. It will be very surprising if a constant early diagnostic alteration which is common to all types is found. The most likely possibility lies in the detection of a diminution in the whole blood or plasma volumes in the traumatic type of shock, and these determinations have not yet been perfected to the extent that they are practical under most emergency conditions. The finding of hemoconcentration is of value in those instances such as burns, in which the fluid which is lost is plasma rather than whole blood, but it is not the usual early observation when red blood corpuscles as well as plasma are lost. At any rate, efforts which are directed toward the determination of the early alterations should continue, for it is generally agreed that significant alterations of the systolic blood pressure may be a late finding.

Discussion in this paper will be limited to a consideration of four types of injuries, namely: blast, burns, crush injuries, and trauma to large masses of muscle. Careful clinical studies are few in number, and it is for this reason that much of the discussion will deal with experimental observations.

BLAST

Except for the observations of Hooker on the effects of blast on the arterial and venous pressures, little was known about the nature of injury until the present war. The British have reported a number of cases in which

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death was produced by blast, even though there was no sign of injury to any external part of the body. A number of recent experimental studies have been performed on this condition, and notable among these are those of Zuckerman and his associates (17). They performed a series of experiments in which rabbits' trunks were protected while their heads were directly exposed to high blast pressures, and it was found that the thoracic and abdominal lesions which result from blast are due to the wave acting on the surface of the body and not to either the pressure or the suction components of the wave acting through the nose and mouth. They conclude that the thoracic and abdominal lesions are primarily due to the impact of the pressure component on the body wall and that the lesions can occur when the suction component is excluded. It is found that, in animals exposed to high blast pressures, concussion does not occur. There are a number of ways in which blast may cause death. Immediate death unassociated with external trauma in some instances is due to occlusion of the larger bronchi by blood clot. Delayed death is due usually to pulmonary edema, and less often to intraperitoneal hemorrhage.

The experimental studies coincide very closely with the clinical observations in that intrapulmonary hemorrhage is the most frequent finding. This is at least one condition in which the intravenous administration of large quantities of blood and blood substitutes seems to be contraindicated. The use of oxygen and morphine is indicated. The induction of general anesthesia is contraindicated.

BURNS

It has been often stated that this is a "burn-war" and it is rather generally agreed that at the present time there is no one type of injury that is more important or more frequent. Underhill, Blalock (4), and others have shown that burns result in the local escape of plasma from the blood stream. In 1931 one of us (A.B., 4) stated: "It is impossible to escape the fact that the loss of such large amounts of whole plasma into the burned area must play an important part in causing a reduction in the blood pressure as a result of the diminution in the blood volume. Regardless of whether or not death is due solely to loss of plasma, the present experiments indicate that the fluid loss probably is the initiating factor in the decline in blood pressure. After the blood volume is reduced and the blood is very concentrated, it is likely that toxins, if present, even in small amounts, will exert deleterious effects since elimination by the kidneys is greatly reduced. In the human being, the factor of loss of fluid after burns may be even more important than in the dog, since there is copious weeping from the injured skin in man, and this is not encountered in dogs. It is entirely possible that such agencies as tannic acid and epinephrin exert their beneficial effects by preventing loss of fluid rather than by stopping the absorption of toxins." These results have been confirmed and amplified by Harkins and others. Most of the experiments have been of relatively short duration and the results do not exclude the possibility of the deleterious effects of slowly acting decomposition products. Longer experiments are complicated by the necessity of continuous anesthesia.

Approximately 80 per cent of deaths which are due to burns occur within the first 2 days. It is in the early stage that the local loss of plasma is such a prominent feature. Although positive proof is lacking, it is likely that infection and toxemia play an important part in the cause of deaths which occur 24 hours or later following a burn. Aldrich says that when there is no infection there is no toxemia, but there is a good deal of evidence which supports the toxemia theory. Wilson and his associates (21) found that edema fluid gradually acquires toxic products. Drinker and his associates (12) have obtained evidence recently that the lymph which is collected from a burned area exerts toxic effects on subsequent injection.

All are agreed that as a result of burns there is a great loss of plasma from the blood stream. There is some difference of opinion as to the relative rôles of local and of general loss in the cause of peripheral circulatory failure. It is our opinion that the early loss of plasma is mainly local and that the general loss occurs later. Regardless of when the loss occurs, the best means of preventing or treating the cir-

culatory failure consists of the intravenous administration of large quantities of plasma or serum. The injection of large amounts of solutions of crystalloids is contraindicated because it may result in a further depletion of plasma proteins (3). If the quantity of plasma which is available is limited, the initial injections should not be very large, since it has been shown by Rhoads, Lee and Wolff that the loss of injected plasma is more rapid during the early stages following the burn than it is subsequently. These observers have found, what was previously only an impression, that the application of tannic acid reduces the local loss of plasma.

Since it appears likely that under most circumstances blood plasma will be available for the treatment of patients with burns, the crying need is for some product which will decrease capillary permeability or for an agent which will destroy the hypothetical toxic products which return to the general circulation from the burned area. In addition, there is a need for a cheap, rapidly drying local agent with antiseptic properties which can be applied quickly. The present war will probably result in many advances in the general and local treatment of burns.

CRUSH INJURIES

Several articles appeared before and during the first World War in German periodicals on the effects of crush or compression injuries, and it was noted that peculiar renal lesions may occur. The condition then appears to have escaped attention until fairly recently, when the British medical literature has contained reports of a number of cases. Most of these crush injuries have occurred in association with air raids in which persons have been trapped beneath fallen débris.

The essentials of the clinical history and observations are as follows:

1. Compression of limb for several hours or longer.
2. Crushed ischemic muscle.
3. Frequently local anesthesia.
4. Swelling of extremity, hemoconcentration.
5. Shock, favorable response to therapy.
6. Progressive oliguria.
7. Urine contains albumin, brown or black granular casts. Gross blood in some cases.
8. Uremia.
9. Jaundice, rarely.
10. Gangrene of injured extremity.
11. Death in approximately two-thirds of reported cases.

The autopsy findings which have been reported include the following:

1. Muscle necrosis.
2. Kidneys enlarged, moist cut surface, pallor and mottling of cortex, congestion of pyramids.
3. Homogenous masses in Bowman's capsule.
4. Necrosis and regenerative changes in cells of 2d convoluted tubules.
5. Increase in interstitial tissue about these tubules.
6. Brown or black granular casts in 2d convoluted tubules.
7. Tubulovenous lesions consisting of aneurysmal bulges in ascending limb of Henle's loop with damage to tubular epithelium and adjacent venule.

The various forms of treatment which have been used or suggested include the following:

1. Treatment of shock.
2. Promotion of diuresis.
3. Alkalinization of urine.
4. Intermittent positive pressure.
5. Amputation (fatal result).
6. Multiple incisions into extremity (fatal result).
7. Tight bandaging of injured limb.
8. Tourniquet with intermittent or slow release.
9. Atropine or papaverine (relief arterial spasm).
10. Adrenal cortical extract.

We have attempted to reproduce the condition experimentally. After the employment of several methods, such as the application of a tourniquet to the thigh and the compression of an extremity between the flat surfaces of boards, it was apparent that the degree of injury to the tissues was not sufficiently great. The method which was eventually devised consisted of compressing the thigh between uneven surfaces. This was accomplished by fixing triangular strips of wood on the inner surfaces of two boards. The strips were arranged so that their coaptation would result in an interdigitation or cog-like arrangement when the two boards were placed opposite each other on the thigh, and approximation of the boards was caused by shortening the springs which were placed at the four corners. A groove was made in the center of each of the insets of triangular strips of wood. When the press was in place these grooves corresponded to the course of the femur, and thus the greater

TABLE I.—CRUSH INJURY—5 HOURS' DURATION

Type of experiment	No. of experiments	Decline in blood pressure 4–6 hrs. after pressure removed mm. HG	Change hematocrit in % of control figure 4 to 6 hrs. after pressure removed	Survivals	Average duration survival of others	Fluid loss % body weight
Control* No therapy	19	50	45	1	7° 33′	3.26
Pneumatic tube 13 to 18 hrs.	21	16.9	28.5	15	26° 20′	3.26
Plasma therapy 3.3% body weight	15	25.3	29.6	6	19°	5.3
Ice coincident with crush	7	10.7	10.7	5	1 at 13 hrs. 1 at 5 days	0.59
Ice subsequent to crush	6	20.0	38.9	0	11° 30′	3.69

*Important findings included swelling of leg, hemoconcentration, decline in blood pressure, oliguria, abnormal urinary findings, elevated blood creatine, creatinuria.

part of the pressure was on the soft tissues of the thigh rather than on the femur. The pressure which was transmitted to the thigh was approximately 500 pounds. Medium-sized animals with well developed muscles were chosen. The press was usually left in place for 5 hours. Pain was prevented by the use of nembutal and morphine. Further details are given in a previous article (9).

Nineteen control experiments were performed in which the press was applied for 5 hours, and no form of therapy was carried out after its removal. The only significant alterations which were noted during the 5 hour period were the appearance of red blood cells and albumin in the urine. The nonprotein nitrogen and plasma creatine levels increased slightly in some animals during this time, and a slight increase in urinary creatine was found in some of the animals. No significant alterations in blood pressure, pulse rate, hematocrit reading, respiratory rate, or rectal temperature were observed during this 5 hour period.

The alterations which occurred following the removal of the press were pronounced. The arterial pressure usually declined immediately and remained depressed for a few seconds before returning to, or almost to, the normal level. Beginning 15 to 30 minutes later there was a slowly progressive decline in arterial blood pressure until death ensued. The pressure had usually declined about 50 millimeters of mercury at the end of 4 hours after removal of the press. Progressive hemoconcentration occurred in all experiments except one, the average increase at the end of 4 hours being 44 per cent above the control level. Gross discoloration of the urine due to blood and possibly myohemoglobin was noted at the end of 1 hour following removal of the press. Red blood cell casts and granular casts were observed in most of the experiments, but these could not be definitely identified as the large dark brown casts described in human cases. Blood and urinary chemical changes included an elevation in nonprotein nitrogen, an increase in plasma creatine and creatinine levels, and creatinuria. Eighteen of the 19 animals died, the average survival period being 7 hours and 33 minutes. Bisection of the posterior part of the body and comparison of the weights of the injured and noninjured sides showed an average local fluid loss into the injured area which was equal to 3.3 per cent of the total body weight. The fluid in the injured part was yellowish in color and contained very few red blood corpuscles. The findings at autopsy were in general characteristic of those observed in shock. Histological examination of the kidneys revealed areas of dilatation of the renal tubules with flattening of the epithelium, but the characteristic degenerative lesions which have been described in patients were not found. Some of the results in these experiments are given in Table I, and the results of one experiment are shown graphically in Figure 1.

Additional experiments have been performed with several aims in view. Shock can be produced more uniformly by the employment of this method than by any other with which we are familiar, and it seemed to be de-

sirable to inquire further into its pathogenesis. We were interested in knowing whether or not shock produced in this manner could be treated successfully. Since in the control experiments the survival period was much shorter than in the clinical cases of crush syndrome, the studies on therapy presented the added objective of trying to determine whether the typical syndrome would develop if life were prolonged by some form of treatment.

The first attempts at therapy were made by applying a pneumatic rubber tube to the injured extremity immediately after removal of the mechanical press. The tube was fitted with a valve which was connected to a compressed air supply. It was inflated constantly at a pressure of 40 millimeters of mercury. The pneumatic tube was left in place for 13 hours in some experiments and 18 hours in others, a total of 21 experiments being performed. When applied for 13 hours, 3 of the 6 animals died following crush injury, whereas when applied for 18 hours, only 3 of 15 died. The average survival time of the 6 animals which succumbed was 26 hours 9 minutes. The alterations in the various determinations of most of the experiments were less pronounced than those of the previous untreated group. Some of the observations are listed in Table I. It seems likely that the pneumatic tube exerts its beneficial effect by diminishing the loss of fluid into the injured area.

The therapeutic effect of the local application of cold to the injured extremity has been studied (10). In the first 7 experiments, the ice was applied simultaneously with the press and was left in place for the same length of time, namely, 5 hours. Five of the animals survived and the changes were minimal. There was very little swelling of the extremity and the alterations in the blood pressure, hematocrit readings, and urinary findings were much less marked than those in the control experiments. One of the remaining 2 animals died 5 days later of pneumonia. The cause of death of the other animal was not ascertained.

In 6 experiments ice was applied to the injured extremity shortly after the press was removed. No beneficial effect was observed.

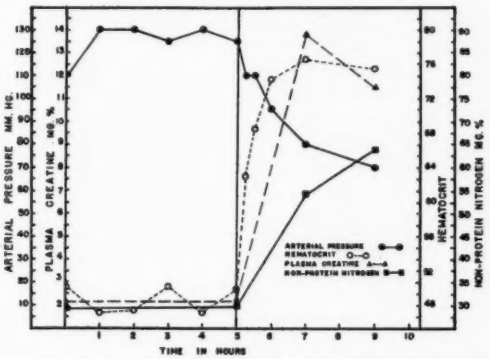

Fig. 1. The effects of removal of the press on the arterial blood pressure, the hematocrit reading, the plasma creatine and non-protein nitrogen.

It seems likely that the favorable effect in the studies in which the ice was applied earlier was due to a lowering of the metabolism of the part during the period of anoxia. The results of these experiments are given in Table I.

The third form of therapy that was used consisted of the intravenous administration of blood plasma. The quantity of plasma which was given equalled 3.3 per cent of the body weight of the animal. This was the average loss of plasma into the injured extremity of the untreated group. The injection of plasma was begun immediately after removal of the press and it was administered slowly over a 1 to 2 hour period. A total of 15 experiments of this type was performed. Nine animals died during the first 40 hours following the removal of the press in an average of 20 hours, the 6 remaining animals survived for 23 days or longer. The alterations in the various functions that were studied were not as great as in the untreated animals. All the animals which died within 40 hours showed numerous granular and red cell casts in the urine and considerable hematuria, whereas the 6 which lived showed only an occasional granular and red cell cast. Examination of the injured extremity of the animals treated with plasma which died within 40 hours revealed swelling which was more pronounced than that found in the untreated group. Bisection and comparison of the weights of the injured and noninjured parts showed a local loss equal to 5.3 per cent of the body weight as compared to 3.3 in the

untreated group. Thus, an additional loss equal to 2 per cent of the body weight took place into the injured area, which left unaccounted for a little more than one-third of the plasma which was injected. This observation suggests that an additional factor or factors contribute to the fatal results in these animals.

The 6 surviving animals were observed for approximately 50 days. None of the animals showed casts or hematuria after the first few days. Plasma and urinary creatine and creatinine reached normal by the second day and remained within the limits of the control values. We were, however, again unsuccessful in our efforts to produce the delayed renal alterations which have been described in clinical cases.

In a further effort to understand the effects of crush injuries, it seemed desirable to perform experiments in which the duration of the crushing injury was longer (15 instead of 5 hours), and to determine whether or not death could be prevented by the administration of plasma in doses which were comparable in size to the estimated loss of plasma into and near the crushed area. Four experiments of this type have been performed and death within 30 hours following removal of the press has occurred in all instances, despite the fact that the quantity of plasma introduced was at least equal to the total loss of fluid into the injured extremity. This suggests very strongly that toxic products are formed as a result of the gross injury and the prolonged period of ischemia and anoxemia, and that these exert ill effects when absorbed into the general circulation. The fact remains that the local loss of fluid is great and that it alone would probably have caused shock had not replacement therapy been employed. The beneficial effect which results when the injured part is refrigerated during the compression period suggests that the ischemia and resulting anoxia are more important in the sum total of the effects of the crush injury than is the actual gross injury to the tissues.

The type of injury which is produced by this apparatus is one in which a large mass of skeletal muscle is crushed and most, if not all, of the circulation to the extremity is occluded for the time while the press is in place. The pulse cannot be felt distal to the press, but it can be felt immediately after its removal. Thus, local mechanical injury, ischemia, and anoxia play a part in the injury of the extremity and in the large regional loss of plasma. The marked hemoconcentration is further evidence of the loss of plasma. The animals treated by the pneumatic tube were probably saved by the lessening of the fluid loss as a result of the local pressure.

As previously stated, we have been unable to reproduce completely the crush syndrome with delayed death which has been observed in patients. As a result of the clinical and experimental observations, several of the possible causes of the crush syndrome will be mentioned as follows: (1) One of us (G.W.D., 8) has noted tremendous elevations in inorganic phosphorus in animals with crush injuries. It has been previously found that a diet high in phosphate results in tubular lesions in the kidneys of rats. It is possible that this alteration is important in the crush syndrome in patients. (2) Anuria, tubular lesions, and casts have been found to follow mismatched transfusions, the lesions being very similar to those found in the crush syndrome. Most of the patients with the crush syndrome have received transfusions, but this was not the case in at least one instance in which the typical renal lesions were found. (3) Adenylic acid has been said to be responsible for at least part of the tubular damage in mismatched transfusions, and this substance and other products of muscle metabolism may exist in the injured anoxic muscle. (4) One of the chief features in all the reported cases of crush syndrome has been the presence at some time of shock, the recorded criteria of which are low blood pressure and hemoconcentration. Peripheral circulatory failure may play a part in the precipitation of crystalline and particulate matter. It has been shown that the precipitation in the tubules of particulate matter, such as sulfapyridine crystals, is increased in the presence of a low blood pressure, and (5) there are a host of possible other toxic products in the injured ischemic tissues.

Upon the basis of the evidence at hand, it seems most likely that prolonged ischemia of an extremity, with subsequent flooding of the

general circulation with metabolic products from the ischemic extremity when the constricting object is removed, is of greater importance in the etiology of clinical crush syndrome than direct mechanical injury alone. Further studies are needed in order to determine the possible rôle of infection in the causation of the syndrome.

TRAUMA TO SOFT PARTS

Gross trauma to the soft parts of an extremity is a good method of producing shock because it reduplicates a type of injury that is often encountered in patients and because the opposite nontraumatized extremity can be used as a control. Severe trauma to an extremity is followed by the loss of blood into the tissues of the part and by little alteration in the concentration of corpuscles in the blood vessels, slight hemodilution being the usual observation. Milder trauma is followed by the escape of plasma with relatively few red blood corpuscles into and near the injured part, and by hemoconcentration. There is some difference of opinion as to the cause of shock which may follow severe trauma to an extremity, but the prevailing opinion at the present time is that the main initiating factor is the local loss of fluid into and near the injured area (5, 18). There seems to be little doubt that this is the case in shock which develops within the first few hours following the injury. It must be said, however, that the absorption of toxic products and the effects of nervous stimuli have not been excluded as important agencies in the causation of shock following this type of trauma. This is particularly true in those instances in which shock develops a number of hours after the injury.

Proof that shock can be produced experimentally when the local loss of fluid is restricted was presented by Freedman and Kabat in studies in which they traumatized extremities that had been bound with tape. The agencies other than the local loss of fluid which are responsible for shock produced in this manner require further investigation. It is of interest that Freedman and Kabat found that preliminary transection of the upper lumbar spinal cord prevented the development of shock as caused by their method.

From the experimental viewpoint, it may be stated that shock which can be explained on the basis of local fluid loss alone can be produced by gross trauma to extremities. On the other hand, it seems quite likely that other factors play a part in many instances of gross trauma. The rôle of the nervous system is difficult to evaluate because anesthesia is required. It seems unlikely that nerve stimuli ever serve as the sole initiating agent, but it is probable that they play a part in the cause of shock.

Probably the best clinical study of shock is that which was recently reported by Whitby and his associates (16). It is commented upon in this place because most of the patients had injuries to soft parts. They made a systematic study of 24 patients who had been severely injured. A typical example is the following case report.

"CASE 3. Male, aged 24. Seen 3½ hours after injury. Multiple small injuries of back, legs and arms, gaping hole in right buttock 9 in. in diameter, buttock almost completely removed, perforating wound left wrist joint. Morphia gr. ¼ 1¼ hours after injury. Warmed with electric blanket for 1¼ hours before transfusion. Mentally clear, pain 2 plus, thirst 1 plus, pallor 2 plus, cyanosis 2 plus, sweating slight, T. 95° F., P. 82, B.P. 40/30, Hb., ear 120%, vein 100%, hæmatocrit 43%.

"After 1 pint plasma in 20 min. P. 100, B.P. 70/40. After 2nd pint plasma in 20 min. P. 120, B. P. 80/45. After 3rd pint plasma in 20 min. P. 128, B. P. 100/55, Hb., ear 80%. Greatly improved but pallor still extreme; 1 pint blood given in 30 min. P. 120, B. P. 100/60. Started bleeding from buttock; 1 pint blood given in 30 min. During operation of débridement, at which much bleeding, 2 further pints blood administered, each in 15 min. Anæsthetic G.O.E. After operation P. 110, B. P. 112/70. After 24 hours general condition good; P. 120, B. P. 115/80, Hb. 78%."

A number of statements by Whitby and his associates are of sufficient importance to merit repetition. They state: "In all cases seen by us it has appeared that the loss of blood-volume can be accounted for by external loss and by extravasation into the injured area. In no case has there been any evidence to suggest loss of plasma in regions remote from a seat of injury." Even though we have stressed for a number of years the importance of the local loss of fluid in the cause of shock, it would be surprising if in Whitby's patients there were

not other factors which played a part in the cause of traumatic shock.

In connection with the search for a universal early criterion of shock, the statements by Whitby and his associates are discouraging. They found that the pulse rate is an unreliable indicator and that in the absence of blood pressure readings attention should be paid to the volume of the pulse rather than to the rate. It was noted that the cardinal symptoms of shock may be present without much hemoconcentration or hemodilution. They state: "In observing 24 cases of secondary shock a sustained and serious fall in blood pressure, in spite of simple resuscitation procedures, has been found to be the one reliable clinically measurable criterion of the severity of the condition." In most instances of secondary shock vasoconstriction is present, and thus the arterial blood pressure may remain elevated even after a rather pronounced decrease in the blood volume and cardiac output. Hence, the decline in blood pressure is usually not an early alteration in shock, and it is to be hoped that an earlier index will be found. For the present, we are inclined to agree with Grant and Reeve in their statement that in assessing the need for treatment emphasis should be placed on the severity of the injury and on blood loss, rather than on the blood pressure.

Blood pressure determinations are of particular value in evaluating the response to treatment. Whitby and his associates state that, as a rule, a rise of 10 to 20 millimeters of mercury can be anticipated for every 540 cubic centimeters transfused, if bleeding has ceased and no other causes of loss of circulating plasma are operating. A quantitative replacement of lost fluid should be attempted. It is fortunate that the old custom of not giving more than one pint of blood to a patient has been discarded. If the injury is severe, usually several pints are required.

A series of experiments has been performed recently which adds to the information regarding the mechanism of shock following injury to soft parts, and, in addition, the results demonstrate clearly the harmful effects which may follow the prolonged use of a tourniquet. An extremity was traumatized as in previous experiments by striking the thigh of the anesthetized animal a number of blows with a hammer. An attempt was made to produce the same amount of injury that had been caused in the previous studies. Shortly following the traumatization, blood plasma was given intravenously in an amount which equalled 5 per cent of the body weight of the animal. All of these animals recovered. In a second series of experiments, the trauma was carried out in an identical manner and immediately a tourniquet consisting of heavy rubber tubing was placed tightly around the thigh just proximal to the site of trauma. The tourniquet, which was placed on tightly enough to cut off the arterial inflow as well as the venous return of the soft parts, was left in place for 5 hours. It is to be remembered that a similar period of ischemia was caused in most of the experiments on crush injuries. There was no evidence that the condition of the animals changed materially during this 5 hour period. As soon as the tourniquet was removed, the intravenous administration of plasma was begun and the amounts given in the various experiments varied from 5 to 10 per cent of the body weight of the recipient. Even the use of the larger quantities did not prevent the death of the animals. In some of the experiments the loss of plasma into the injured part was not so great as the quantity which had been injected.

These studies indicate very clearly that vastly different effects are produced by (1) trauma alone and (2) the same amount of trauma plus the prolonged application of a tourniquet. When gross trauma alone is caused, most of the alterations can be explained on the basis of local loss of fluid. When ischemia and anoxia are superimposed by the prolonged application of a tourniquet, the local loss of fluid following the removal of the tourniquet is great; but death is not prevented by introducing fluid which is sufficient to replace the local loss. In other words, some general type of alteration in the circulatory system is produced. Burns result in the death of some tissues and probably in a diminution in the blood supply of some parts which ultimately survive. It is quite possible that the effects of burns are intermediate between

gross trauma alone, on the one hand, and trauma on which ischemia is superimposed, on the other.

From a practical standpoint, these studies emphasize what is known but is not generally appreciated regarding the harmful effects of the use of tourniquets on the injured extremities of patients. Wilson and Roome (22) found that the removal of a tourniquet is followed by the passage of a considerable portion of the blood volume into the dilated vessels of the extremity, and at times by a decline in blood pressure. A tourniquet should be used for the control of bleeding only if other measures are not available or are not adequate. It was noted by Allen that constriction of the circulation of the thigh is more likely to be followed by the development of shock if the temperature is high than if it is low. Brooks and Duncan found that the temperature of the part is of great importance in determining the survival period of ischemic tissue. Our experiments on crush injuries show that many of the ill effects can be avoided by refrigerating the part during the time in which anemia and ischemia are present. If it is necessary to use a tourniquet on an injured extremity, these observations indicate that the part distal to the tourniquet should be cooled if facilities for accomplishing this are available.

SUMMARY

Four types of injuries that are frequently encountered in warfare are considered. These are blast injuries, burns, crush injuries, and gross trauma to the soft tissues of extremities. The type and the extent of regional fluid loss in these conditions are discussed.

The observations on crush injuries and gross trauma to soft parts indicate that there is a distinct difference in the effects of trauma alone and of trauma to which an interference with the blood supply to the part is superimposed. The effects of gross trauma alone appear to be mainly local, whereas the addition of ischemia and anemia to trauma results, upon release of the constriction, in general alterations in the circulatory system as well as in local changes.

The results emphasize the desirability of controlling hemorrhage by means other than the application of a tourniquet. If it is necessary to apply a tourniquet, it should be left in place for as short a time as possible unless the part is to be amputated. Cooling of the part distal to a tourniquet greatly reduces the chances of the development of shock following the release of the constriction.

REFERENCES

1. Aldrich, R. H. N. England J. M., 1933, 208: 299.
2. Allen, F. M. Am. J. Surg., 1939, 45: 459.
3. Beard, J. W., and Blalock, A. J. Clin. Invest., 1932 11: 249.
4. Blalock, A. Arch. Surg., 1931, 22: 610.
5. Ibid. 1930, 20: 959.
6. Brooks, B., and Duncan, G. W. Ann. Surg., 1940, 112: 130.
7. Bywaters, E. G. L., and Beall, D. Brit. M. J., 1941, 1: 427.
8. Duncan, G. W. Unpublished observations, 1942.
9. Duncan, G. W., and Blalock, A. Ann. Surg., 1942, 115: 684.
10. Idem. Shock produced by crush injury. Effects of administration of plasma and local application of cold. Arch. Surg. In press.
11. Freedman, M., and Kabat, H. Am. J. Physiol., 1940, 130: 620.
12. Glenn, W. W. L., and Drinker, C. K. Personal communication, 1942.
13. Grant, R. T., and Reeve, E. B. Brit. M. J., 1941, 2: 329.
14. Harkins, H. N. The Treatment of Burns. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1942.
15. Hooker, D. R. Am. J. Physiol., 1924, 67: 219.
16. Kekwick, A., Marriott, H. L., Maycock, W. D'A., and Whitby, L. E. H. Lancet, 1941, 1: 99.
17. Krohn, P. L., Whitteridge, D., and Zuckerman, S. The Lancet, 1942, 1: 252.
18. Parsons, E., and Phemister, D. B. Surg. Gyn. Obst., 1930, 51: 196.
19. Rhoads, J. E., Lee, W. E., and Wolff, W. A. Personal communication, 1942.
20. Underhill, F. P., Kapsinow, R., and Fisk, M. E. Am. J. Physiol., 1930, 95: 315.
21. Wilson, W. C., Jeffrey, J. S., Roxburgh, A. N., and Stewart, C. P. Brit. J. Surg., 1937, 24: 601.
22. Wilson, H., and Roome, N. W. Arch. Surg., 1936, 32: 334.

PLASMA THERAPY IN SEVERE BURNS

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THE general treatment of burns is of prime importance and must be carefully correlated with the local therapy. The management of the patient attempts to bring him past four serious stages in the chronological course of a burn, namely: (1) primary shock, (2) shock, (3) toxemia, (4) infection.

As shown in Figure 1, these four stages overlap, but in general they have rather definite times of appearance. The general treatment of burns should be directed against deaths occurring during these four stages. The steady progression of abnormal developments requires, however, that such treatment should be rapidly instituted, continuously carried out, and meticulously followed through as long as is necessary.

For all practical purposes, the treatment of primary and secondary shock need not be separated. Nine times out of ten, by the time the patient has reached the hospital, even though all the signs of primary shock have not disappeared, evidences of secondary shock will already be present in instances in which that condition is going to develop. Harkins (1934, 1935) reported the results of tipping experiments on dogs subjected to unilateral trauma. These demonstrate that 50 per cent of the total plasma shift in such animals will have already occurred at the end of the first hour. Clinical observations of the hematocrit indicate that when hemoconcentration occurs, such an increase is liable to be in evidence early. Penberthy (1941) reported that the most marked rise in the hematocrit occurs during the first 6 hours. Penberthy had one patient with very severe burns and a hematocrit of 70 per cent at the end of 1 hour after the burn, indicating a loss of approximately one-half of the normal plasma volume. Tenery (1940) stated in this regard that in clinical cases the hematocrit rises rapidly "so that approximately one-half of the hemoconcentration that is likely to occur is present at the end of 6 hours." These observations indicate the early onset of signs of secondary shock and the fallacy of trying to separate its treatment from that of primary shock.

In the early stages of a severe burn it is desirable that the course of the patient be followed by adequate laboratory and clinical tests. Such observations aid in deciding upon the choice and dosage of therapeutic agents. The following routine is suggested as ideal, but except in large institutions or in military hospitals during periods of relative inaction, such a schedule would have to be trimmed considerably. Of all the determinations listed here, observation of the hematocrit (or hemoglobin or red blood count) is the most important. No other single test gives as much information concerning the status of a burn patient from a therapeutic standpoint. Hemoconcentration, not arterial blood pressure fall, is the first sign, as a rule, of impending burn shock and therefore of the necessity for fluid replacement. In shock of no other origin does uncomplicated hemoconcentration occur so often as after burns. The wise surgeon should take advantage of this singular opportunity.

Suggested determinations include:

a. Chart *blood pressure* every 2 hours the first 48 hours and every 8 hours the next 5 days unless below 90 systolic when more frequent readings are necessary.

b. Chart *temperature*, *pulse*, and *respiration* every 2 hours.

c. Chart daily *fluid intake* and *output*, with specific gravity of each urine specimen the first 3 days and later if the daily output is below 1200 cubic centimeters.

d. Determine the *hematocrit* (or hemoglobin or red blood count) every 3 hours during the first 12 hours and thereafter if elevated, and daily for the first week. Subsequently, if secondary anemia develops, as it

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TABLE I.—BERKOW'S METHOD FOR ESTIMATING THE EXTENT OF A BURNED AREA

Region	Per cent body surface involved
Head	6
Upper extremities	
Both arms and forearms	13½
Both hands	4½
Total	18
Trunk	
Anterior surface	20
Posterior surface	18
Total	38
Lower extremities	
Both thighs	19
Both legs	13⅓
Both feet	6⅓
Total	38

does so frequently after third degree burns, these same determinations are of great value in the control of this late complication.

e. Optional observations include a daily *white blood count, urinalysis*, and blood chemical examination. For the latter, *plasma proteins, icteric index, carbon dioxide combining power, chlorides*, and *plasma potassium* are useful in more or less decreasing importance.

TREATMENT OF TOXEMIA AND SEPSIS

The management of burn shock should be carried out along with preventive measures against toxemia and sepsis.

Toxemia. This complication is especially apt to occur during the second to the fourth day after a burn. The presence of jaundice, increase in the icteric index, decrease in the urinary output, stupor, and a demonstrable decrease in liver function are all prodromal signs. The liver function tests show a decrease in prothrombin percentage (Table II Case 1) and hippuric acid excretion and an increase in bromsulfalein retention and a positive cephalin cholesterol test. Adequate glucose (more than 150 gms. daily) and sufficient sodium chloride to maintain equilibrium (usually 1000 c.c. of normal salt solution daily, although when vomiting occurs more should be given in accordance with well known surgical principles) are advised. Use of these crystalloid solutions in reasonable amounts as well as of adrenal cortical extract to prevent burn toxemia conforms with the control of burn shock.

Sepsis. The treatment of sepsis is largely preventive by the use of careful local therapy and therapeutic by the adoption of adequate sulfonamide control. In either instance, the early treatment of shock is not impeded.

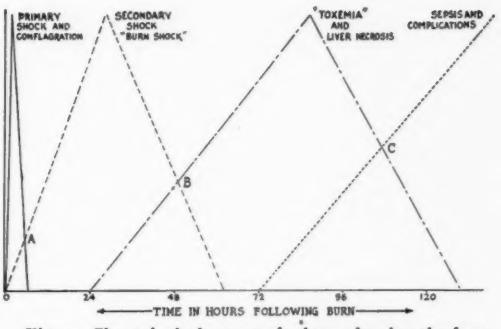

Fig. 1. Chronological course of a burn showing the four serious stages. From *O* to *A*, primary shock is predominant; from *A* to *B*, secondary shock; from *B* to *C*, toxemia; after *C*, sepsis and complications. (Modified from Gunn and Hillsman.)

RELATION TO LOCAL TREATMENT

Tannic acid and other tanning agents have done more to reduce the mortality during the first 48 hours than during the later course of burns. Whether the tanning method does this by sealing off the damaged tissues and preventing fluid loss or by precipitating and diminishing the absorption of toxic products is still uncertain. But the fact remains that during this period the mortality has been markedly diminished. Even granting, then, that certain local remedies may give a better cosmetic result on the face or hands, it would seem that in severe burns local treatment should be chosen with an eye toward the prevention of shock and saving of the life of the patient rather than only to the ultimate cosmetic result. In the absence of adequate plasma for transfusion, tanning should promptly be applied in severe burns; in such cases oils and saline dressings or baths should be reserved for mild extensive or localized deeper burns. The vaseline gauze-pressure dressing method of local burn treatment also helps minimize the local loss of plasma.

TREATMENT OF BURN SHOCK

The treatment, essentially consisting of 4 types, is both prophylactic and therapeutic.

TABLE II.—MISCELLANEOUS CHEMICAL STUDIES OF CASE T.W.

Date	7–30 (1941)	7–31	8–1	8–2	8–5	8–7	8–8
Blood chemical analysis							
N.P.N (mgm. per 100 c.c.)	47.9			25.2		66	71.4
Chlorides (mgm. per 100 c.c.)	373			333	427	514	
Sodium (mgm. per 100 c.c.)	293			311			
Potassium (mgm. per 100 c.c.)	26.2			17.3			
Sugar (mgm. per 100 c.c.)						400	528
Sulfanilamide (mgm. per 100 c.c.)					4.6	5.3	3.5
CO_2 (vols. %)						43.5	32.1
Prothrombin (%)				20	5	25	
White blood count		6,900			17,600	10,500	13,800
Liver function test:							
Oral hippuric acid test (gms.)			3.48			2.49	

1. Supportive treatment. Rest and quiet are advisable. Elevation of the lower extremities is useful as a temporary emergency remedy but does not get at the source of the trouble. Warmth may be harmful in excess as shown by Hilgenfeldt (1939) and by Blalock and Mason (1941). For this reason it is best not to have burn tents warmer than 85 degrees F. Sedatives are useful for relieving early pain, but later may exaggerate a tendency toward anoxia. Stimulants are of value only when respiratory depression is present. Vasospastics are essentially a symptomatic remedy and give only a temporary benefit.

2. Oxygen. This is of value in all serious cases. Nasal catheters may be used in mild cases and oxygen tents in more serious instances when a higher concentration of oxygen is desired. In extreme cases the B.L.B.[1] mask with its capability of giving 90 per cent oxygen, or more, should be applied.

3. Adrenal cortical extract. This mode of therapy is still in an experimental stage, but offers much promise as a specific remedy. Differentiation should be made between relatively pure glandular extracts, impure glandular extracts, and synthetic desoxycorticosterone acetate which may not all have the same therapeutic effect. Rhoads, Wolff, and Lee (1941) reported that without adrenal cortical extract, about 40 hours are required for the capillary walls to recover their normal state of permeability for proteins. When adrenal cortical extract was given, such a *restitutio ad integram* occurred as early as the eighteenth hour.

4. Fluid replacement therapy. This is the cornerstone of all burn shock treatment. Crystalloid solutions (saline and glucose) have only a temporary benefit, but in small amounts are necessary adjuncts to other more specific therapy. Whole blood is not harmful, but in the early stages of treatment, its contained erythrocytes are superfluous. However, like a diet with much bulk, it is far better than nothing.

Blood plasma is the best treatment known at the present time for the treatment of burn shock. Since it is essentially plasma which is lost in burns rather than whole blood, the use of plasma would seem logical. Its adoption was suggested by Low (1937), Montgomery (1937), and Seeger (1938). Weiner, Rowlette, and Elman (1936) in a study of 40 severely burned patients first reported the clinical use of plasma in such cases. In their report, it was shown that intravenous glucose and saline accomplished little, the plasma protein levels continuing to decrease and the hemoconcentration continuing to increase. Intravenous gum acacia or plasma, however, was definitely of benefit. During the past 3 years the use of plasma has been the chief development in the general management of burns. Plasma has been used by Elkinton in 1939; by Atkins; Black; Cohen; Darrow; Elkinton, *et al.*; Minot and Blalock; Noland and Wilson; Scudder;

[1] Boothby, Lovelace, and Bulbulian.

Tenery; Vaughan; Wakeley; and White, Collins, and Weinstein in 1940; by Allen; Elman; Harkins; Lam; Penberthy; and Robson and Wallace in 1941; and by Harkins (1942).

DOSAGE OF PLASMA

The administration of adequate amounts of plasma is essential. There is no more reason for always giving a burned patient a pint of plasma than for always giving a diabetic patient 10 units of insulin. Large amounts of plasma have been given by some writers. Strumia, Wagner, and Monaghan (1940) gave 7,300 cubic centimeters of plasma to one burned patient in 11 days. Minot and Blalock (1940) gave a patient with severe burns 5,000 cubic centimeters of blood plasma as well as other amounts of whole blood and other fluids during the first 19 days of illness. Large amounts of plasma were also given by Rhoads, Wolff, and Lee (1941) and by others.

With the necessity for administration of large amounts of plasma, the advisability of methods for calculation of the plasma dosage is evident. Such dosage is best controlled by careful and repeated estimation of the blood concentration (hematocrit, hemoglobin, or red blood cell count). With blood banks available it is relatively easy in civilian practice or in military hospitals during periods of relative inaction to obtain large amounts of plasma. The adoption of preserved or dried plasma extends its usefulness to the front line and active engagements.

There are 4 methods available for calculating the plasma dosage, as follows:

a. First aid method of Harkins (1941). In many cases in which burns are treated in places remote from hospitals or near the front line in war, plasma may be available yet methods for determining hemoconcentration may not. In such instances the extent of the burn and consequent plasma dosage can be roughly calculated by Berkow's method (Table I). For deep burns (arbitrarily, those deep enough to cause blistering), the rule can be adopted of giving *50 cubic centimeters of plasma for every per cent of the body surface affected* by such a burn. This could also be expressed as a pint of plasma for each 10 per cent of the body surface so involved.

b. Method of Black (1940). As used in Great Britain, this involves the following formula:

X = amount of plasma to be given in c.c.

$$X = \left(5 - \frac{500}{Hb_2}\right) 1{,}000$$, where Hb_2 is the hemoglobin observed after the burn

c. Method of Elkinton, Wolff, and Lee (1940). This involves the use of an even more complicated formula and takes into account both the extent of hemoconcentration and possible low plasma proteins.

Y = amount of plasma to be given in gm.

$$Y = 3.5\ W - \frac{W\ (100 - Ho)\ HnPo,}{2\ (100\text{-}Hn)\ Ho}$$, where

W = body weight in kgm.
Ho = observed hematocrit
Hn = normal hematocrit (= 44)
Po = observed plasma protein in gm./100 c.c.

This formula can be simplified from this unwieldly form substituting the assumed value of 44 for the patient's normal hematocrit, and by expressing the result in cubic centimeters of plasma to be given instead of in grams (since donor's plasma is never analyzed quantitatively anyway).

X = amount of plasma to be given in c.c.

$$X = 49\ W - \frac{5.5\ (100 - Ho)\ Po\ W}{Ho}$$

d. Method of Harkins (1941). This is the simplest of the methods depending on extent of hemoconcentration. It is to give *100 cubic centimeters of plasma for every point the hematocrit exceeds the normal of 45.* This formula can be adapted to hemoglobin estimations, in which the dosage should be 50 cubic centimeters of plasma for every point the hemoglobin exceeds the normal of 100 per cent. The method involves the same assumption as the other methods, namely that the patient's preburn blood concentration was normal. The amount of plasma is calculated for adults, while for children it can be reckoned proportionately according to the body weight, the average adult weight being assumed to be 70 kilograms. When the plasma protein is below normal, the simplified method gives too low a value. If such a hypoproteinemia is present, an additional 25 per cent of the calculated

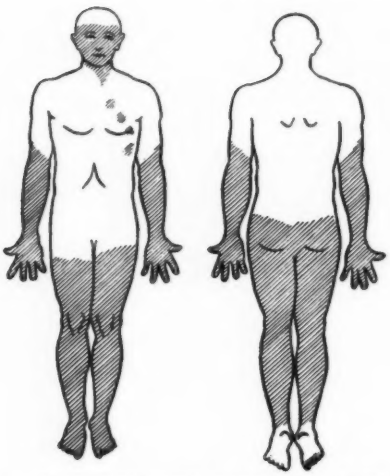

Fig. 2. Diagram of burned areas of patient T. W., Case 1. Berkow formula shows: head, 3 per cent; hands, 4.5 per cent; arms, 8 per cent; feet, 2.5 per cent; legs, 13 per cent; thighs, 17 per cent; a total burned area of 48 per cent of body surface.

amount of plasma should be added for every gram the protein level is below 6.0 gm./100 cubic centimeters. In adequately treated cases experience has shown, however, that low plasma proteins are seldom observed in the first few weeks after a burn. Only when no blood or plasma has been given and when the blood has been diluted by large amounts of intravenous crystalloid solutions are low plasma proteins apt to be observed. Thus, the correction to Harkins' formula for such an eventuality seldom need be considered in actual clinical practice.

Four illustrative cases will now be analyzed and the results by the four methods compared.

CASE 1. T. W., No. 338592, male, aged 18 years, received second and third degree burns of approximately 48 per cent of the body, as shown in Figure 2. Patient's clothing was ignited by hot molten metal at 3 p.m. on July 28, 1941. He was treated at hospital 1 hour later by débridement followed by a tannic acid bath and the application of resorcitannol and silver nitrate. Shock developed temporarily despite the early use of plasma. He received 4700 cubic centimeters of plasma during the first 28 hours. July 29, 1941, 5 cubic centimeters of adrenal cortex was given twice intravenously with plasma, then every 2 hours intramuscularly for 20 hours; finally, 2 cubic centimeters every 4 hours intramuscularly until stopped August 6, 1941. Thirty grains of sulfanilamide was given orally August 4, 1941, then every 4 hours for 3 days. One tablet kayquinone was given three times a day starting August 5, 1941, Synkamin, 1 ampul, was given twice a day August 5, 1941, then 2 ampuls twice a day, August 6, 1941. August 7, 1941, old insulin was started and he received a total of 148 units in divided doses before he expired at 7:50 p.m. August 8, 1941, with blood sugar 528 despite no recent glucose injections. Daily specimens of urine showed: albumin, 0 to 2+; casts, only first 2 days; sugar 1+ to 4+; ketone bodies absent; no red blood cells; few white blood cells. Bile was present on the 2 days before death. The results of various blood chemical analyses are shown in Table II. A complete outline of the calculations of the plasma dosage at various times is given in Table III. As seen from this table, the admission hematocrit 2 hours after the burn at 5 p.m. was 56. It had risen to 73 4½ hours later despite the administration of 600 cubic centimeters of plasma.

Peak hematocrit was 73 per cent; plasma protein, 7.33 grams per 100 cubic centimeters; body weight, approximately 70 kilograms; 2250 cubic centimeters plasma given in 12 hours.

Calculation of plasma dosage:

a. First aid formula. Since 48 per cent of the body surface is involved by a deep (blistering) burn, the total plasma dosage should be 2400 cubic centimeters (50 c.c. for each per cent).

b. Formula of Black. (This and the following 3 illustrative calculations will be made for the 9:30 p.m. hematocrit reading only.)

Hematocrit of 73 corresponds to hemoglobin of 160.

$$X = \left(5 - \frac{500}{160}\right) 1000 = 1880$$

∴ 1880 c.c. plasma needed.

c. Formula of Elkinton and associates.

$$X = 49 \times 70 - \frac{5.5 \times 27 \times 70 \times 7.3}{73}$$

$$X = 2190$$

∴ 2190 c.c. plasma needed.

d. Formula of Harkins.

Hematocrit of 73 is 28 points above normal or 45 and plasma protein is above 6.0 gm./100 c.c.

∴ 2800 c.c. plasma needed.

A comparison of the results of the four formulas indicates a reasonably good agreement. As seen in Table III, this agreement for the three main formulas holds good for the entire period of observation during the first week following the burn. In fact, there is less

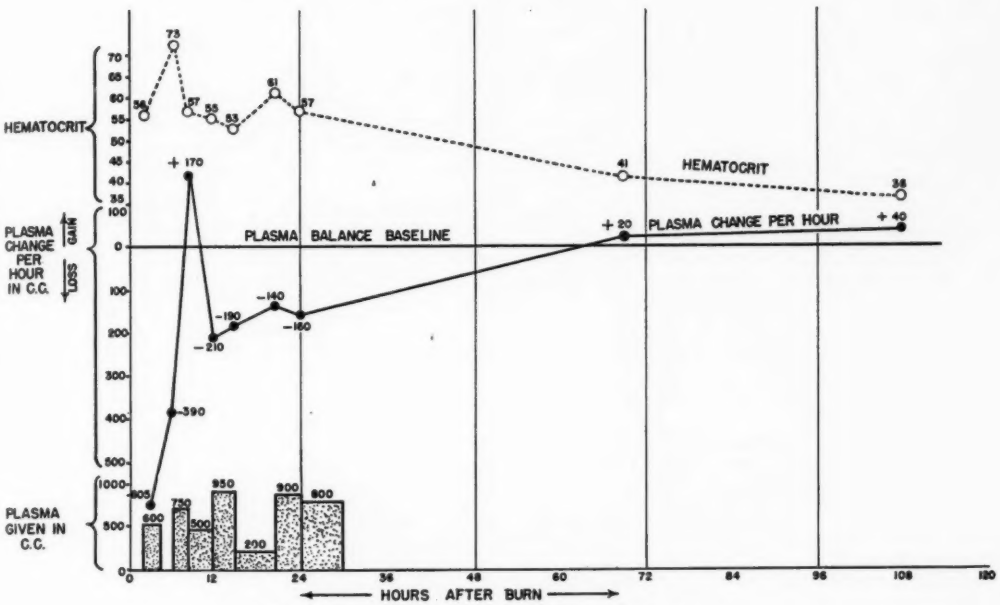

Fig. 3. Plasma balance studies of patient T. W. Case 1.

disparity in most of the results than in the illustrative example used above. During the recovery period the calculations by the simplified formula do not take into account excesses of plasma. From the practical standpoint this is not important.

Another way of charting the plasma balance is shown in Figure 3. This type of chart is new and represents a modification of that used by Rhoads and associates (1942). The hematocrit readings are graphed at the top and the amount of plasma is given at the bottom. The middle line represents the plasma change per hour in cubic centimeters. This is listed as a loss (negative values) or a gain (positive values) in the calculated amount of plasma in the blood stream. In this particular chart, the values are calculated by the formula of Elkin-

TABLE III.—CALCULATION OF PLASMA DOSAGE DURING FIRST WEEK AFTER BURN IN CASE OF T.W.

Time	7 - 28 - 41			7 - 29 - 41				7-31-41	8-2-41	8-5-41
	5 p.m.	9:30p.m.	11:30p.m	1 a.m.	5 a.m.	11:30a.m	3 p.m.			
Hematocrit	56	73	57	55	53	61	57	41	36	35
Hemoglobin (calculated from hematocrit)	124	162	126	122	118	134	126	91	80	78
Plasma protein (gm/100 c.c.)	7.33	*	*	*	*	*	*	6.10	6.32	7.47
1. Calculated plasma dosage, c.c. (Method of Elkinton et al.)	1210	2390	1300	1120	930	1640	1300	50	−880	−1910
2. Calculated plasma dosage, c.c. (Method of Black)	970	1910	1030	870	770	1270	1030	−490	−1260	−1420
3. Calculated plasma dosage, c.c. (Method of Harkins)	1100	2800	1200	1000	800	1600	1200	0	0	0
Actual amount of plasma given, c.c. (after readings)	600	750	500	950	200	900	800	0	0	0

*Plasma protein assumed to be 7.33.

TABLE IV.—CALCULATION OF PLASMA DOSAGE DURING FIRST WEEK AFTER BURN IN CASE OF B.S.

Date	2-11-41 (a.m.)	2-11-41 (p.m.)	2-12-41	2-13-41	2-14-41	2-15-41	2-17-41
Hematocrit	57	62	56	52	49	40	36
Hemoglobin (calculated from hematocrit)	126	137	124	115	109	89	80
Plasma protein (gm./100 c.c.)	7.5	7.0	8.1	5.9	6.0	5.9	5.7
1. Calculated plasma dosage: method of Elkinton, et al., c.c.	1250	1760	970	1290	970	20	−460 (excess)
2. Calculated plasma dosage: method of Black., c.c.	1040	1350	970	650	410	−620 (excess)	−1250
3. Calculated plasma dosage: method of Harkins, c.c.	1200	1700	1100	700	400	0	0
Actual amount of plasma given (after readings) c.c.	300	1200	700	0	0	0	0

ton and associates, although the method of Black or that of one of us (H.N.H.) would have given comparable values. The first point on this line represents an average plasma loss from the blood stream per hour of 605 cubic centimeters at a time 2 hours after the burn (5 p.m.). This is calculated from the results shown in Table III. The Elkinton formula indicates a 1210 cubic centimeter deficit after 2 hours or 605 cubic centimeters per hour. The second point showing an average loss of 390 cubic centimeters per hour is calculated similarly. At 9:30 p.m. the Elkinton formula indicates a 2390 cubic centimeter deficit. This is 1180 cubic centimeters more than at the last reading and exists despite the administration of 600 cubic centimeters plasma. The new loss occurring from 5 p.m. to 9:30 p.m. is thus 1180 plus 600, or 1780, divided by the time interval of 4½ hours. This equals 390 cubic centimeters per hour. Other points are calculated accordingly. We have no explanation for the one aberrant point (the third) on the plasma change line. It undoubtedly illustrates the inaccuracies of the methods, and may mean that the previous peak hematocrit of 73, which was taken from very sluggish capillary blood (from an abdominal skin puncture wound), represents too high a value. Despite this, the steady decrease in plasma loss with a complete recovery of plasma balance on the third day is of extreme interest. The time of this recovery roughly corresponds with that reported by Rhoads, Wolff, and Lee (1941). Since this particular patient received adrenal cortical extract, the slowness of recovery does not in itself argue for the use of this drug. More likely, however, the late return to nor-

TABLE V.—CALCULATION OF PLASMA DOSAGE DURING FIRST FIVE DAYS AFTER BURN IN CASE OF W.K.

Time	8-6-41			8-7-41		8-8	8-9	8-11
	1 p.m.	5 p.m.	11:30p.m	9 a.m.	4 p.m.			
Hematocrit	46	48	57	52	52	49	47	40
Hemoglobin (calculated from hematocrit)	102	107	126	116	116	109	105	89
Plasma protein (gm./100 c.c.)	6.70	6.55	*	6.55	6.62	6.47	†	†
1. Calculated plasma dosage, c.c. Method of Elkinton et al.	480	830	1850	1330	1300	1010	750	−360
2. Calculated plasma dosage, c.c. Method of Black	100	330	1040	690	690	420	240	−620
3. Calculated plasma dosage, c.c. Method of Harkins	100	300	1200	700	700	400	200	0
Actual amount of Plasma given, c.c. (after readings)	0	500	0	0	650	0	0	0

*Plasma protein assumed to be 6.55
†Plasma protein assumed to be 6.47

mal represents the combined effects of extreme damage to the capillaries and administration of very large amounts of plasma. In no other patient did we encounter such high values for the plasma loss per hour. For example, in Case 2, the highest loss observed was 210 cubic centimeters per hour. It is to be noted, however, that this last figure represents an average over a six hour period, while the high figure for the first case is over only the first two hour period when the leakage is most rapid.

CASE 2. B.S., male, aged 21, with severe burns shown in Figure 4, was admitted with a hematocrit of 57. His course is shown in Table IV. Three hundred cubic centimeters of plasma was given immediately after the initial hematocrit. The patient was burned at 3 a.m. on February 11, 1941, when his oil-soaked clothes caught on fire after an oil stove had exploded. Resorcitannol jelly and, later, sulfaguanidine were applied locally. The patient received 2 cubic centimeters of cortate intramuscularly every 4 hours for 5 days and one dose of 1500 units of tetanus antitoxin. He was given 2200 cubic centimeters of blood plasma during the first 36 hours after the burn. He was never in severe shock, but died April 7, 1941, 55 days after the burn.

Calculation of plasma dosage:

a. First aid formula. Since 43 per cent of the body surface is involved by a deep (blistering) burn, the total plasma dosage should be 2150 cubic centimeters (50 c.c. for each per cent).

b. Formula of Black. Hematocrit of 57 corresponds to hemoglobin of 126.

$$X=\left(5-\frac{500}{126}\right)1000=1040.$$

∴ 1040 c.c. plasma needed.

c. Formula of Elkinton and associates.

$$X=49\times68-\frac{5.5\times43\times7.5\times68}{57}$$

$X=1250$

∴ 1250 c.c. plasma needed.

d. Formula of Harkins.

Hematocrit of 57 is 12 points above normal of 45 and plasma protein is above 6.0 gm./100 c.c.

∴ 1200 c.c. plasma needed.

The agreement between the methods b, c, and d is striking, both for this determination and for subsequent ones shown on Table IV.

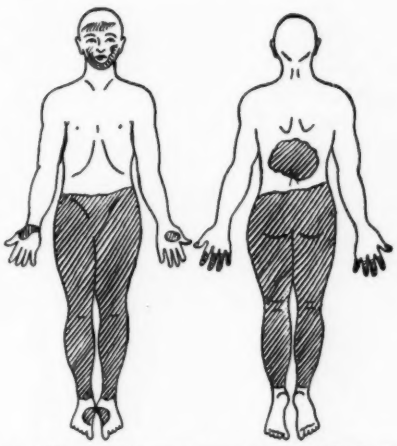

Fig. 4. Diagram of burned areas of patient B. S. Case 2. Berkow formula shows: 1/3 of head, 2 per cent; 1/36 of hands and arms, 0.5 per cent; 1/7 of anterior trunk, 3 per cent; 1/4 of posterior trunk, 4.5 per cent; both thighs, 19 per cent; both legs, 14 per cent; a total of 43 per cent of body surface.

The larger amount of plasma (2150 c.c.) indicated by method a, the first aid formula, would at first glance seem a discrepancy. Actually, however, it is not, as this formula indicates at one reading—as well as can be done, it is believed—the entire amount of plasma that will be necessary. The other methods indicate fractionally that amount which is required at different periods during the course of the burn. It is to be observed that the actual amount of plasma given, 2200 cubic centimeters, corresponds almost exactly to that calculated by the first aid formula.

CASE 3. W.K., No. 339121, white male, aged 37 years, with 20 per cent of the body surface burned, was treated as follows (Table V): Patient was admitted to the hospital August 6, 1941. He had been burned at 10:55 a.m., when a gas burner ignited while he was cleaning a furnace. His hands were further burned as he attempted to remove clothing. He was brought to the hospital within an hour and presented no evidence of shock. Local treatment consisted of cleansing of the wounds with green soap and débridement. Wounds rinsed with saline. Tannic acid spray was followed by 10 per cent silver nitrate except over the hands and face which were treated with cod liver oil ointment and pressure dressings. He received a total of 1150 cubic centimeters of citrated plasma in two transfusions during the first 28 hours. Infection was minimal and healing was rapid. Epithelization was complete by September 13, 1941 with practically no scarring or functional impairment.

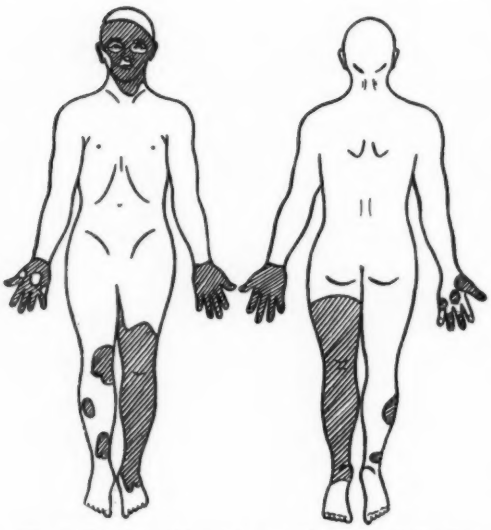

Fig. 5. Diagram of burned areas of patient M. K., Case 4. Berkow formula shows: ½ of head, 3 per cent; 1 hand and ¾ of other, 3.5 per cent; ½ of 1 thigh, 9.5 per cent; 1 leg, 7 per cent; a total of 23 per cent of body surface.

Calculation of plasma dosage:

a. First aid formula. Since 20 per cent of the body surface is involved by a deep (blistering) burn, the total plasma dosage should be 1000 cubic centimeters.

b. Formula of Black. (This and the subsequent two calculations are for the maximum hematocrit of 57 shown in Table V.)

Hematocrit of 57 corresponds to hemoglobin of 126.

$$X=\left(5-\frac{500}{126}\right)1000=1040$$

∴ 1040 c.c. of plasma needed.

c. Formula of Elkinton and associates.

$$X=49\times 85-\frac{5.5\times 43\times 6.55\times 85}{57}$$

$X=1850$

∴ 1850 c.c. plasma needed.

d. Formula of Harkins.

Hematocrit of 57 is 12 points above normal of 45 and plasma protein is above 6.0 gm./100 c.c.

∴ 1200 c.c. plasma needed.

In this case the formulas agree fairly well. Again the first aid formula indicates the total dosage and this is essentially what was given (1000 calculated, 1150 given). Because of the fact that the Elkinton formula takes better cognizance of the weight of the patient, it led to higher values for the plasma needed than did the two other formulas. The differences in this case were not, however, therapeutically significant.

CASE 4. M.K., male, aged 38 years, admitted with severe gasoline burns of lower extremities estimated at 23 per cent of the body surface as shown in Figure 5. Initial hematocrit was 60 per cent; initial plasma protein, 6.68 grams per 100 cubic centimeters; body weight, 80 kilograms; 2000 cubic centimeters of plasma given in 12 hours.

Calculation of plasma dosage:

a. First aid formula. Since 23 per cent of the body surface is involved by a deep (blistering) burn, the total plasma dosage should be 1150 cubic centimeters.

b. Formula of Black.

Hematocrit of 60 corresponds to hemoglobin of 132.

$$X=\left(5-\frac{500}{132}\right)1000=1210$$

∴ 1210 c.c. plasma needed.

c. Formula of Elkinton and associates.

$$X=49\times 80-\frac{5.5\times 80\times 40\times 6.68}{60}$$

$X=1960$

∴ 1960 c.c. plasma needed.

d. Formula of Harkins.

Hematocrit of 60 is 15 points above normal of 45 and plasma protein is above 6.0 gm./100 c.c.

∴ 1500 c.c. plasma needed.

After 2000 cubic centimeters of plasma were given this patient the new hematocrit was 45 (normal); new plasma protein was 6.49 grams per 100 cubic centimeters; and no further plasma was needed.

EFFICACY OF PLASMA IN CONTROLLING BURN SHOCK

The importance of burn shock, especially in time of war, is evident. Various estimates have put the percentage of burn deaths that are due to shock at from 60 to 75 per cent of the total number of deaths. Wilson (1928) reported that 63 per cent of his 80 burn fatali-

ties occurring from 1913 to 1925 were from shock; Seeger (1937) reported a shock death percentage of 64 per cent of his total burn deaths, and Klotz (1938) reported 70 per cent. The most recent figures in this regard are those of Atkins (1940) who had considerable experience in treating burn cases evacuated from Dunkerque. This writer stated: "Secondary shock is the most serious factor in burns and is responsible for 60 per cent of the deaths occurring in this condition." Naturally, with adequate therapy the figure will not run this high, but the fact still remains that in about two-thirds of serious burn cases patients will die of burn shock if untreated. It should be pointed out, however, that many patients may be saved during the shock period only to die later of other complications. Such a fate was met by two of our own most serious cases (Cases 1 and 2).

The work of others on the efficacy of plasma in controlling shock and hemoconcentration has been borne out. The simple first aid formula devised by one of us (H.N.H.) gives quantitative data concerning plasma dosage which compare favorably with those obtained from blood concentration studies. When these latter are available, the simple rule *to give 100 cubic centimeters of plasma for every point the hematocrit is above the normal of 45* yields results that are therapeutically as accurate as the more complicated formulas of Black and of Elkinton, Wolff, and Lee. Since the first aid formula indicates immediately the total amount of plasma needed, this had better not be given too fast and should be divided roughly as follows: one-third the first 2 hours, one-third the next 4 hours, one-third the next 6 hours.

Use of the status of the peripheral circulation as a guide to regulate plasma administration as recommended by Rhoads and associates (1942) is also advisable. This should be done especially when the various formulas indicate that large amounts are necessary. Administration of plasma as slowly as is consistent with maintaining the peripheral circulation is the conservative thing to do until the value of plasma is proved in a large series of cases. Although we are sure that in our 2 fatal cases death would have come much sooner if plasma had not been given, we still cannot say that plasma prolonged their lives. Aside from this slight element of uncertainty, the use of plasma seems to be the best thing for a severe burn patient in shock.

Besides its use in controlling burn shock, plasma has a definite place in controlling the hypoproteinemia which results late in the course of burns and which interferes with healing and the taking of skin grafting. This aspect of the subject has been discussed elsewhere by one of us (H.N.H., 1942).

CONCLUSIONS

1. Plasma is the best available agent for the treatment of burn shock.

2. The administration of plasma should be quantitatively adjusted to fit the patient.

3. There are 4 methods of calculating the plasma dosage. When no laboratory facilities are available, use of the *first aid formula* is suggested, whereby 50 cubic centimeters of plasma is given for each per cent of the body surface (as calculated by the Berkow method) involved by a deep (blistering) burn.

4. The 3 other methods of calculation of plasma dosage depend on the determination of the extent of hemoconcentration. The formulas of Black, and of Elkinton give accurate results, but the method described in this paper is therapeutically just as reliable and is much simpler. This method is as follows: *the amount of plasma needed can be roughly calculated for an average-sized adult as being 100 cubic centimeters plasma for every point the hematocrit exceeds the normal of 45*, as long as the plasma proteins are above 6.0 grams per 100 cubic centimeters. When the plasma proteins are below 6.0 grams per 100 cubic centimeters, an additional 25 per cent of the calculated amount of plasma should be added for every gram the protein level is below 6.0.

REFERENCES

1. ALLEN, H. S. J.Am.M.Ass., 1941, 116: 1370-1373.
2. ATKINS, H. J. B. Guy's Hosp. Gaz., Lond., 1940, 54: 192-195.
3. BLACK, D. A. K. Brit. M. J., 1940, 2: 693-697.
4. BLALOCK, A., and MASON, M. F. Arch. Surg., 1941, 42: 1054-1059.
5. COHEN, S. M. Brit. M. J., 1940, 2: 754-755.
6. DARROW, D. C. J.Am.M.Ass., 1940, 114: 655–660.
7. ELKINTON, J. R. Bull. Ayer Clin. Lab., 1939, 3: 279–292.

8. Elkinton, J. R., Wolff, W. A., and Lee, W. E. Ann. Surg., 1940, 112: 150–157.
9. Elman, R. J.Am.M.Ass., 1941, 116: 213–216.
10. Harkins, H. N. Proc. Soc. Exp. Biol., N.Y., 1934, 31: 994–995.
11. Idem. Arch. Surg., 1935, 31: 71–85.
12. Idem. The Treatment of Burns with Particular Emphasis on the Management of Burn Shock, Brochure distributed in connection with Scientific Exhibit, Meeting of American Medical Association, Cleveland, June 2–6, 1941.
13. Idem. The Treatment of Burns. Springfield, Illinois: Charles C. Thomas, 1942.
14. Harkins, H. N., and McClure, R. D. Ann. Surg. 1941, 114: 891–906.
15. Hilgenfeldt, O. Personal communication, January 1939.
16. Klotz (1938). Cited by Harkins (1941).
17. Lam, C. R. Ann. Surg., 1941, 113: 1089.
18. Low, M. B. N. England J. M., 1937, 216: 553–556.
19. Minot, A. D., and Blalock, A. Ann. Surg., 1940, 112: 557–567.
20. Montgomery, A. H. Indust. M., 1937, 6: 639–642.
21. Noland, L., and Wilson, C. H. J.M.Ass. Alabama, 1940, 10: 157–162.
22. Penberthy, G. C., and Weller, C. N. The Treatment of Burns, Scientific Exhibit, Meeting of American Medical Association, Cleveland, Ohio, June 1941.
23. Rhoads, J. E., Wolff, W. A., and Lee, W. E. Ann. Surg., 1941, 113: 955–968.
24. Idem. Paper given before the New York Surgical Society, March 11, 1942.
25. Robson, J. M., and Wallace, A. B. Brit. M. J., 1941, 1: 469–472.
26. Scudder, J. Shock: Blood Studies as a Guide to Therapy. Philadelphia: J. B. Lippincott Co., 1940.
27. Seeger, S. J. The Treatment of Burns, Lewis Practice of Surgery, Vol. I, Chapter 17. Hagerstown, Maryland: W. F. Prior Co., 1937.
28. Idem. Personal communication, September 2, 1938.
29. Strumia, M. M., Wagner, J. A., and Monaghan, J. F. Ann. Surg., 1940, 111: 623–629.
30. Tenery, R. M. Personal communication, November 11, 1940.
31. Vaughan, J. Brit. M. J., 1940, 2: 758–759.
32. Wakeley, C. P. G. Brit. M. J., 1940, 2: 679.
33. Weiner, D. O., Rowlette, A. P., and Elman, R. Proc. Soc. Exp. Biol., N.Y., 1936, 34: 484–486.
34. White, C. S., Collins, J. L., and Weinstein, J. Evaluation of Stored Blood and Blood Serum, Scientific Exhibit, Meeting of the American Medical Association, New York, June 10–14, 1940.
35. Wilson, W. C. Brit. M. J., 1928, 2: 91–94.

THE BLOOD VESSELS OF THE FEMALE PELVIS IN RELATION TO GYNECOLOGICAL SURGERY

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IN continuing a study of the anatomy of the female pelvis and peritoneum the authors have become increasingly aware of the part played by the blood vessels in the support of the pelvic viscera, particularly the uterus and vagina. The abundance of vessels in the region of the Mackenrodt ligaments is so great that in well injected specimens the total bulk of the vascular elements seems to surpass that of the tissues in which they are imbedded. The vessels are prominent not merely in the parametrial substance; they also form an appreciable fraction of the fascial tubes of the viscera as well as of the ligamentous thickenings which support the uterus and the urinary bladder. Moreover, the vessels, and the nerves as well, are disposed in regular strata as they course from source to area of visceral termination.

The drawings of the dissections herewith presented may profitably be examined in connection with illustrations in an earlier contribution on the subperitoneal tissues of the female pelvis.[1]

The dissections were carried out in planned serial order in a selected specimen; each drawing is an accurate representation of a stage in the dissection.

OBSERVATIONS AND DISCUSSION

From the anterior division of the hypogastric artery arise the umbilical artery together with its superior vesical branches, the uterine, and the middle and inferior vesical arteries.

Vesical arteries. In the specimen illustrated there are four vesical arteries derived from the patent proximal part of the obliterated hypogastric (umbilical) artery. They lie in the wing of subserous tissue which passes from the bladder to the pelvic brim.[2] It is a characteristic of pelvic structure that leaf-like formations of fibrous tissue serve as shelves for transmission of visceral vessels and nerves as well as for visceral support. It is as if all of the adventitious tissue of the several vessels were spread out in a continuous sheet to cover the layer of vessels.

Although the superior vesical arteries are multiple, they course, on each side, in a group, toward the point of meeting of the posterior and lateral margins of the bladder. The arteries follow the ureter, resting upon it and paralleling its course on each side. The vessels reach the base of the bladder opposite the line of junction of body and cervix of the uterus. En route they do not send branches to parietal or diaphragmatic musculature.

Upon reaching the bladder they turn medialward, follow a tortuous course within the musculature and ultimately anastomose with the vessels from the opposite side (Figs. 1, 2 and 5). The most anteriorly situated of the superior vesical arteries send branches to anastomose with those of the inferior epigastric artery, bringing visceral and muscular rami into direct communication—a fact important in accounting for the subserous spread of pelvic infection.

Ovarian artery and veins. The ovarian artery and its accompanying plexus of veins enter the pelvis in company with the ureter as the latter crosses at the bifurcation of the iliac. The ovarian artery, which runs parallel with the ureter for some distance, is evidently sometimes confused by surgeons with the ureteric artery; the latter is exceedingly small and is found on the wall of the ureter.

From the Department of Obstetrics and Gynecology and the Department of Anatomy (Contribution No. 371), Northwestern University Medical School, and from the Illustration Studios, University of Illinois.

[1] Curtis, A. H., Anson, B. J., and Beaton, L. E. Surg. Gyn. Obst., 1940, 70: 643.

[2] See Figs. 1 and 2, Curtis, Anson, and Beaton, 1940.

Between the layers of the broad ligament, the artery courses to the mesovarium (Figs. 1 to 3); within the latter it anastomoses at each extremity of the ovary with a branch sent upward from the uterine artery. Twigs are sent to the fallopian tube and round ligament.

Ureteric artery. Upon entering the pelvis the ureter courses downward and forward with the hypogastric artery. Within the broad ligament the ureter passes beneath the bifurcation of the uterine artery (Fig. 3).

The ureter is contained in the tissue which houses the numerous vesical vessels and the autonomic nerves to the bladder. Altogether, the arrangement suggests that of a modified pedicle. The structures are grouped at the margin of the uterus, which organ they must pass to reach the bladder. They produce no elevation of the peritoneum. In addition to minute radicles which are sent to the ureter from the cluster of arteries which surround it, the ureter also receives a vessel of fair size from the hypogastric (Fig. 3).

Uterine and vaginal blood vessels. Beneath the peritoneum of the posterior layer of the broad ligament the vessels are covered by a thin layer of subserous connective tissue which houses the autonomic nerves of the pelvic and uterovaginal plexuses (Fig. 3).[1] Next below the nerve-bearing connective tissue layer, and supported by delicate continuations of it, there is encountered a heavy layer of veins. Upon removal of these, the uterine artery is seen well exposed, intermingled with a deeper stratum of veins provided with a minimal amount of connective tissue; lateralward in the midst of these veins lies the ureter (Fig. 4).

The uterine arteries in the dissected specimens were even more relaxed and tortuous than is evident in the illustrations, where the uterus is held under tension—a feature of clinical interest in emphasizing the fact that these vessels may be held under tension without notable hazard during radical hysterectomy.

In the specimen illustrated, the uterine artery divides on the left where it crosses the ureter; on the right it also divides, but somewhat nearer the uterus (Figs. 1 to 4). Since branching of the uterine artery has been found to be common in dissected specimens, similar instances have been noted clinically. Branching of this sort may account for the occasional spurting of a uterine artery when the surgeon is convinced that it has already been carefully clamped before division.

The uterine vessels exhibit a pedicle-like arrangement at the lateral margin of the viscus (Figs. 3 and 4). The arteries divide en route and again near the uterus to surround both surfaces, meeting their fellows of the opposite side. The set of arteries extends through two-thirds the height of the broad ligament. At the level of the vagina the descending branch of the uterine artery anastomoses with the inferior vesical (vaginal) artery (Figs 1 and 2).

Within the broad ligament the veins are numerous and are arranged in a group with little connective tissue between adjacent vessels. The lowermost vein lies slightly above the uterosacral ligament.

In conformity with observations presented in previous papers concerning the structure of the cellular tissues within the broad ligament, the upper (fallopian tube) region, which is thin and contains very little cellular tissue, also houses very few veins, whereas the Mackenrodt portion of the broad ligament contains a wide expanse of closely interwoven vessels. Immediately inferior to this latter set of vessels, and still within Mackenrodt's ligament, are the ureter, and the ureteric and vesical arteries and veins (Figs. 1 to 4).

Hemorrhoidal arteries. The deepest vascular level is that of the hemorrhoidal vessels. The superior hemorrhoidal artery, descending into the pelvis, divides into four principal branches. The proximal two course along either side of the rectum, giving off many small rami to its wall (Figs. 5 and 6); the distal two pass along the superior surface of the pelvic diaphragm, behind the rectum, one on either side of the midline; these two give branches to the rectum before reaching the anal canal. The laterally directed branches of all four divisions anastomose with branches of the middle hemorrhoidal in the wall of the rectum as it reaches the pelvic diaphragm. The anastomoses occur at a point farther anterior than would be expected, i.e., beneath the vaginal canal (Fig. 5).

[1]A report upon the form, derivation and branches of the pelvic autonomic plexus will appear in an early issue of this journal (A. H. Curtis, B. J. Anson, and F. L. Ashley).

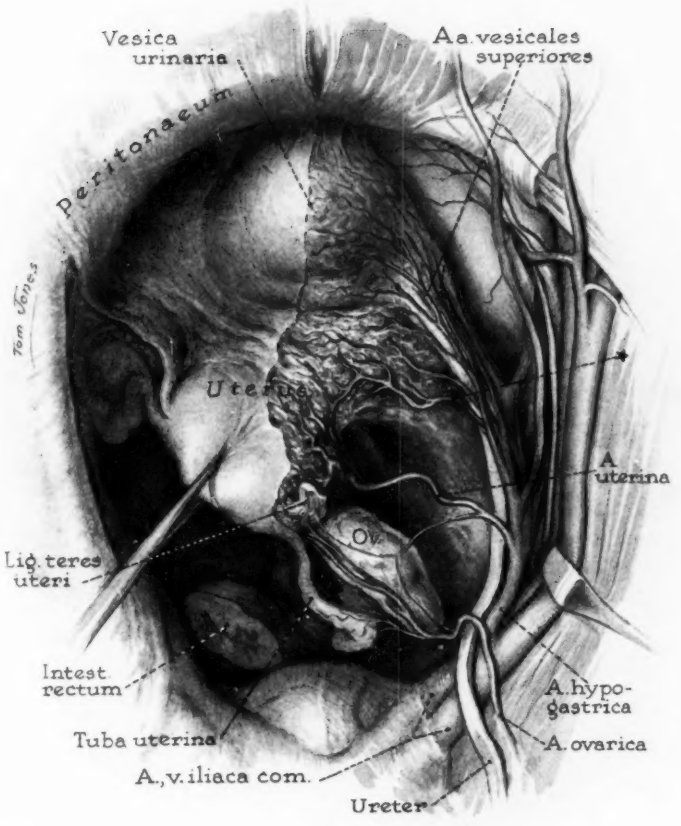

Fig. 1. Vesical, uterine, and ovarian arteries of superficial level, anterior part of pelvis; uterus retrodisplaced under traction toward left. The peritoneum has been almost completely removed on the right. On the same side, the lateral wing of tissue has been dissected and the veins removed to expose the contained vesical arteries, the lateral umbilical ligament, the ureter, and the obturator artery and nerve. The star indicates the vaginal artery, which corresponds to the inferior vesical artery of the male.

The Blood Vessels of the Female Pelvis in Relation to Gynecological Surgery.—Arthur H. Curtis, Barry J. Anson, Franklin L. Ashley, and Tom Jones.

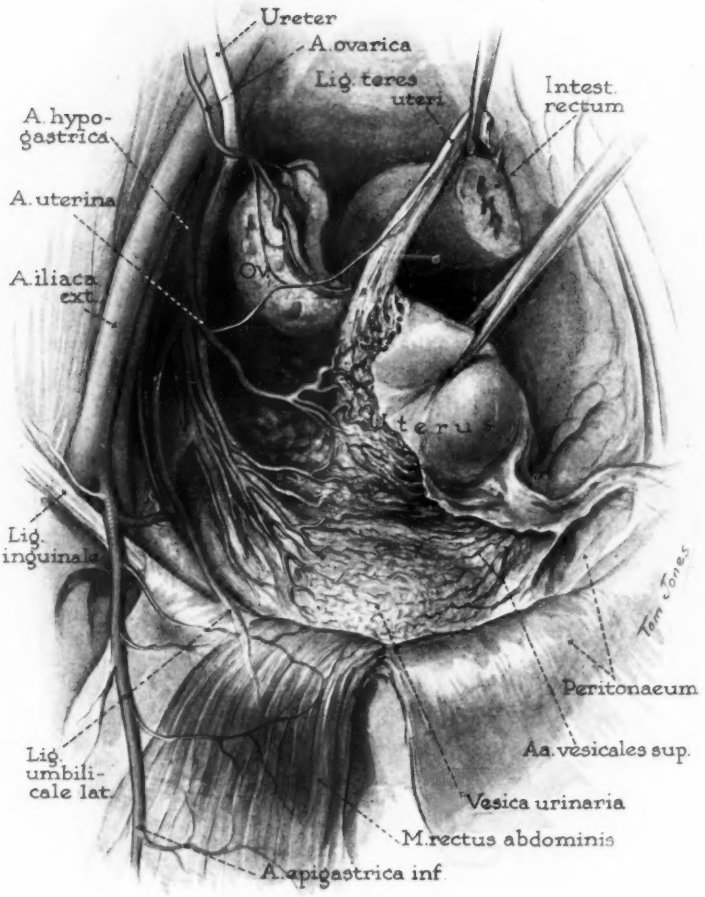

Fig. 2. Dissection extended to left, the uterus retracted toward left side. Supra-pubic view. Arteries retain their *in situ* positions; the terminal rami of the vesical arteries have been more completely exposed, bilateraily, than in Figure 1.

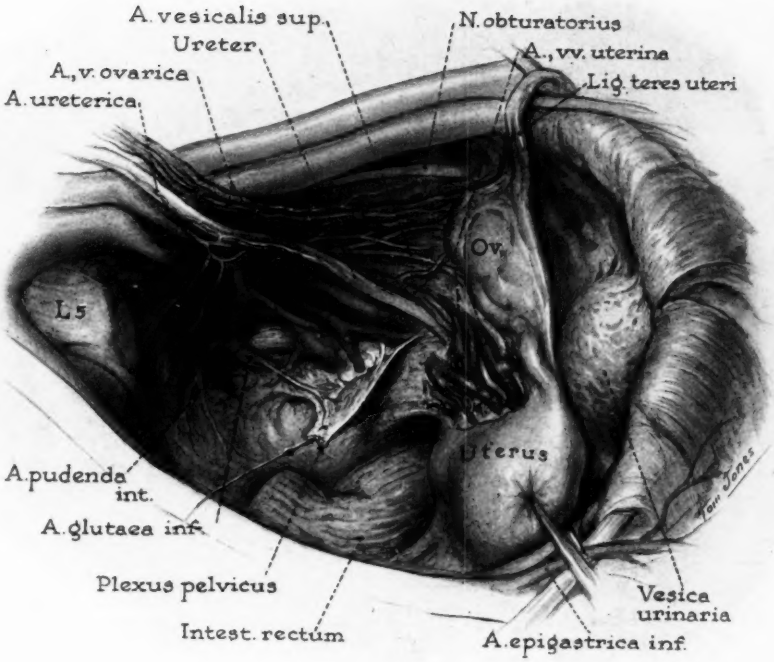

Fig. 3. Arteries and veins of posterior part of left pelvis, uterus retracted to right. The peritoneum and retroperitoneal tissues have been removed from the posterior part of the left broad ligament and from the lateral wall of the true pelvis, thus exposing the vessels. The connective tissue containing the pelvic plexus of nerves has been partially freed and retracted by a hook toward the midline. The parametrial tissue has been removed carefully, the structures maintained in their natural positions, all relations carefully preserved.

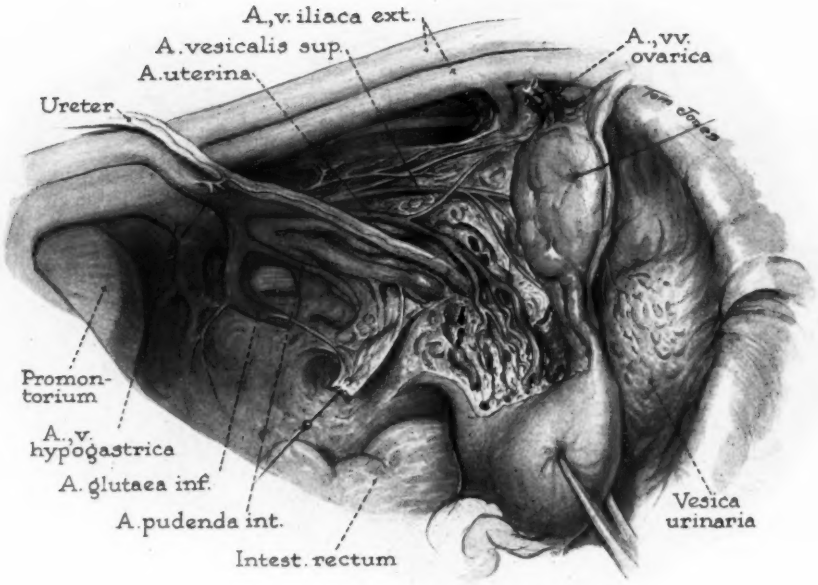

Fig. 4. Uterine arteries further exposed by partial removal of veins. All remaining structures still lie in the positions they held prior to dissection. The ovarian vessels have been removed.

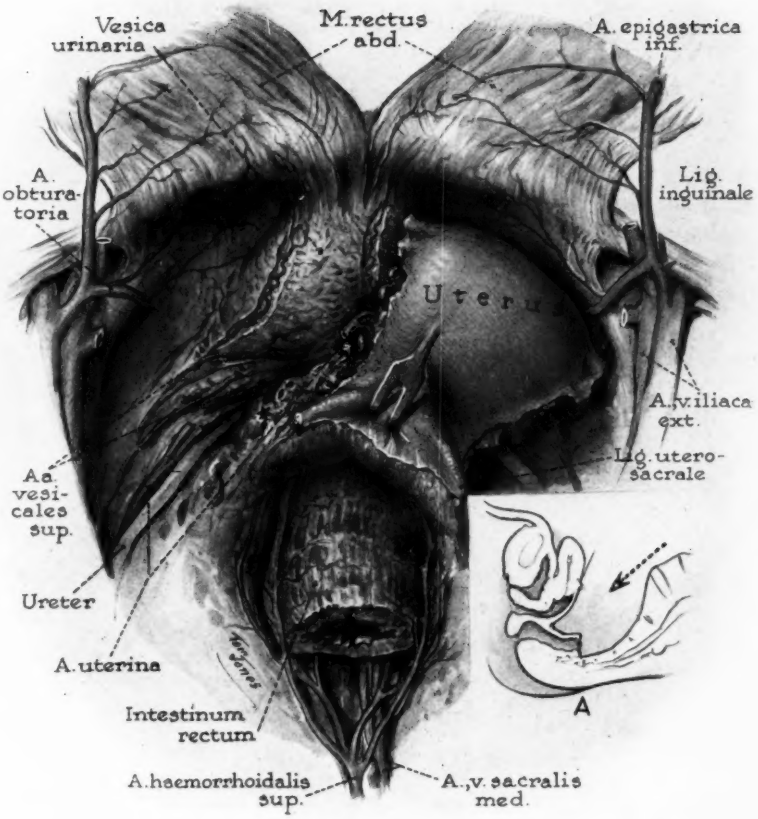

Fig. 5. Arteries of superior surface of bladder, of uterine "hilus," and of terminal rectum; uterus has been drawn forward and toward the right. The uterus is covered with peritoneum over its posterior surface down to the level of the cul-de-sac; the vessels have been cut along its lateral aspect and shown as constituents of a pedicle. On the left the tissue of Mackenrodt's ligament has been removed posterolaterally to vaginal level (at star); this is the plane of division between vesical and uterovaginal vessels. The superior vesical arteries have now been traced to the posterior surface of the abdominal wall. The rectum has been cut to the level of the fourth sacral segment, the hemorrhoidal arteries exposed as they course along its posterolateral aspect. Arrow in inset records direction of view in main figure.

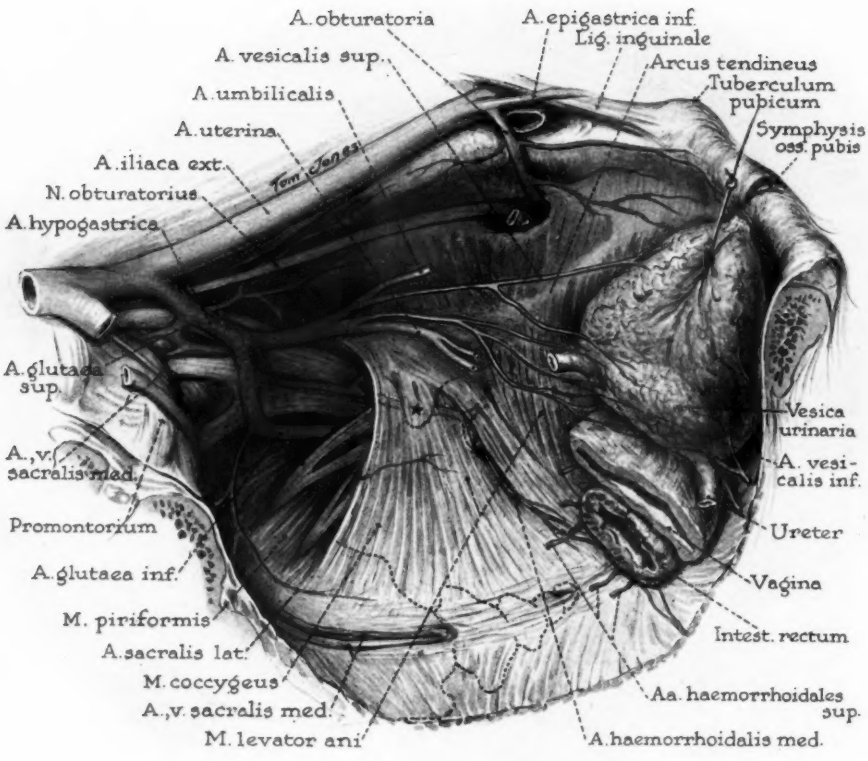

Fig. 6. Arteries of the bladder, vagina, and terminal rectum, exposed by removal of subserous tissue, fascia of pelvic diaphragm, and endopelvic fascial investments. Superolateral view. The right one-third of the pelvis has been removed by a parasagittal cut following the lateral margins of the lumbar vertebral bodies. The rectum and vagina have been transected near the pelvic floor; the urinary bladder is intact but has been pulled forward to expose its base. The external iliac vein has been removed, as have all tributaries of the hypogastric vein. The distal portions of the umbilical and uterine arteries have been removed. Several of the vesical branches of the anterior division of the hypogastric artery remain intact. The internal pudendal, the inferior gluteal, and the lateral sacral branches of the posterior division of the hypogastric are shown. The middle hemorrhoidal in this specimen arises from the internal pudendal, as frequently encountered. The positions of the sacrum, coccyx, and spine of the ischium, as well as the concealed portion of the internal pudendal artery, are indicated by dotted lines; the star marks the point where the internal pudendal artery passes external to the ischial spine.

The four main hemorrhoidal branches, then, rest against the sacrum in postrectal position. This arrangement is gynecologically important; all major branches to the rectum are out of the field of all except radical pelvic surgery.

In this specimen the middle hemorrhoidal artery, derived from the internal pudendal, emerges through a cleft within the substance of the iliococcygeus muscle (Fig. 6). It anastomoses with the superior hemorrhoidal near the point at which the rectum becomes the anal canal (i.e., as it passes through the pelvic diaphragm). Throughout its course the artery rests upon a surface of the pelvic diaphragm, lodged in the thin stratum of areolar tissue under the peritoneum of the rectouterine excavation. Of all the visceral arteries of the pelvis, its course is simplest, its scheme of branching least complex.

Obturator, pudendal and gluteal arteries. The obturator artery in the present specimen does not arise from the hypogastric artery, but from the inferior epigastric (Figs. 1 to 6); such an origin of the obturator occurs in approximately one-fourth of laboratory specimens. The superior gluteal artery arises from the lateral aspect of the proximal portion of the hypogastric; the internal pudendal and the inferior gluteal constitute the posterior division of the hypogastric (Fig. 6).

Pelvic viscera. Perhaps the most striking general feature of pelvic anatomy is the concentration of viscera in the anterior part of the pelvic bowl.[1] The anal part of the rectum, the vagina, and the urethra, all pass through the pubococcygeal component of the pelvic diaphragm, the urethra lying close to the pubic arcuate ligament, the urinary bladder resting upon the pubic bones, the anal canal being placed several centimeters in front of the tip of the coccyx. This means that the visceral vessels, of hypogastric origin, must extend across the greater part of the pelvis to reach the organs which they supply.

[1]Fully discussed and illustrated, Curtis, A. H., Anson, B. J., and Ashley, F. L. Surg. Gyn. Obst., 1942, 74: 709.

CONCLUSIONS

The blood vessels to the pelvic organs of the female, when portrayed *in situ*, are seen to be arranged in three distinct groups and in definite relation to the strata of subperitoneal connective tissue.

The vesical and ureteric vessels accompany the ureter. The vesical arteries are numerous, forming a spray of vessels as they reach, chiefly, the superior surface of the bladder. In coursing forward from hypogastric origin they pass successively through the heavy subperitoneal tissue of the cardinal and broad ligaments, and the endopelvic fascial covering of the urinary bladder. They constitute an intermediate stratum of vessels in the pelvis.

The uterovaginal vessels are superiorly placed; they are lodged in a special "septum," the broad ligament—mainly in its basal part, where the parametrium becomes continuous with the stronger tissue which transmits the vessels to the bladder. The uterine vessels are arranged in such a way that they may be said to form a pedicle.

The hemorrhoidal vessels make up the third and most inferiorly placed group; they descend to the level of the anal canal through the thin subserous tissue on the sacrum and the pelvic diaphragm; they are not associated with the ligamentous supports or fascial investments of the uterus or urinary bladder.

The firm subserous tissue in which the uterus, vagina, and urinary bladder are lodged is locally thickened to form so called "ligaments." Actually, a very considerable part of this bulk is made up of arteries and large and numerous veins, the ligaments appearing to be broadened sheaths for transmission of these vessels. Surgically interpreted, the important function of supporting the viscera must be credited in large part to the presence of the abundant pelvic vessels, particularly the veins.

RESIDUAL LESIONS OF ULCERATIVE GASTRITIS

Possible Relationship to the Development of Carcinoma of the Stomach

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IF the enigma of cancer is to be solved satisfactorily, its pathogenesis must be studied more critically than has been done in the past. The concept that cancer arises from the abnormal proliferation of a single cell which assumes aspects of malignancy from the start and goes on rapidly to the development of a dangerous tumor, may be correct. However, many indications point to the suspicion that in some tumors, at least, years and even decades of preparation may have preceded the appearance of actual malignancy. Studies of polyps of the colon and small tumors of the cortex of the kidney suggest the long period of evolution through which these tumors proceed before clinical manifestations are apparent.

Although the influence of advancing years and hereditary tendencies undoubtedly are factors in releasing the inhibition to unrestrained growth, they probably do not constitute the entire causative background. For many years investigators have debated long and earnestly the pathogenesis of carcinoma of the stomach. It is possible that during this debate the significance of changes in the gastric mucosa which take place over a period of many years has not been stressed sufficiently. Therefore, the present study has been undertaken to evaluate, if possible, the relationship of such changes to the development of carcinoma of the stomach.

REVIEW OF THE LITERATURE

The association of gastric carcinoma with pre-existing gastric changes is by no means a new concept. For many years certain investigators have focused attention on a variously defined condition called "chronic gastritis." Friedenwald, Morrison, and Morrison recalled that as early as 1878 Lebert found varying degrees of inflammation at remote sites in carcinomatous stomachs. At necropsy, of 46 such stomachs, only 5 revealed intact mucosa; 17 displayed some form of gastritis surrounding the carcinoma; 24 exhibited extensive, diffuse gastritis with hypertrophy.

Gastritis is mentioned frequently in the literature, but the term has been abused for many years, especially by clinicians. For a time it fell into disrepute, probably because of unfavorable comments by certain investigators. Postmortem changes and varying degrees of autolysis were commonly noted. Critics were perplexed by the inconstancy of the pathological reports. In many centers, pathologists even refused to recognize gastritis as an entity.

In more recent times, revival of interest in, and stimulation to further study of gastritis have been occasioned by the advances made in gastroscopy. Newer instruments, especially of the flexible type, have provided an improved method of visualization. It will be remembered that an important precursor of this method was recorded by the surgeon, William Beaumont, in his classic observations of long ago.

In 1927, Steinberg reported his careful study of 20 resected stomachs. Twelve of these were ulcerous; 8 were carcinomatous. The specimens had been placed in a fixative of two parts of 80 per cent alcohol and one part of formaldehyde, immediately after resection. Discussing the carcinomatous stomachs, he described what he considered a precancerous mucosa to be: (1) the glands were irregular, disclosing some cysts, heterotopia, and hypertrophy, (2) the tubules and alveoli were larger and more numerous than those of the normal stomach, and (3) the lining cells of the tubules were larger, high columnar, lightly stained, and had nuclei at their bases. Steinberg con-

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Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery.

cluded therefrom that gastritis was marked in carcinomatous stomachs.

In the same year, Faber (4) presented his paper on the sequelae of gastritis. He stated that the end-result of the disease was rarely complete mucosal atrophy and achylia and that the development of gastritis itself was slow and irregular. According to Faber, the form can be preserved and function may return if opportunity is presented. Complete atrophy, Faber thought, resulted only after many years of disease. The incidence of gastritis was therefore quoted as being much higher among old than among young people.

In 1929, Hurst (8) wrote that he considered gastritis to be the most common lesion predisposing to carcinoma of the stomach. In 75 per cent of his cases of gastric cancer the disease was said to have begun in chronic gastritis. " . . . the achlorhydria is a result of chronic gastritis, which precedes the onset of the carcinoma," he wrote, "I have never seen a case of carcinoma in which free hydrochloric acid was present at an early stage and disappeared as the disease advanced."

Hurst stated that, in the presence of gastritis, the gastric glands were plugged by mucus and the gastric juice was dammed back. This reverse pressure was presumed to inhibit further secretion. Therefore, he reasoned, further irritation should open an easy avenue to infection, especially by streptococci. The mucosa was said to thicken, then atrophy. Achylia was the result; recovery to a certain point was known to be possible, but Hurst realized that the atrophied parietal cells would never be replaced. He pointed out that friction is as important in the causation of this type of cancer as it is in the development of cancer in any other portion of the body. Since friction is most pronounced near the pylorus, the irritation arising from it was held to be responsible for the high incidence of cancer in that region as compared to the incidence of cancer in other portions of the stomach.

After brilliant research on the problem of pernicious anemia which resulted in such effective therapeutic control, many investigators anticipated a resultant higher incidence of gastric cancer, since atrophic gastritis consistently afflicts patients having pernicious anemia. By application of the new therapeutic measures, patients' life expectancies were appreciably increased. In 1931, Plummer and Simpson (12) reported on a patient who had had Addison's anemia and who, 5 years after that condition was discovered, died of carcinoma of the stomach. The lesion was situated at the pylorus, on the lesser curvature of the stomach, and was of the annular type. Viewed in microscopic preparation, excess mucin with no oxyntic cells was seen 3 inches (8 cm.) from the margin of the lesion. Closer to the lesion there was more and more "mucoid degeneration." The malignant cells also were loaded with globules; the glandular fundi were dilated, cystic, and lined with low, atrophic cubical epithelium. Many foci of lymphocytes were seen close to the glands.

Plummer and Simpson commented on the sudden change at the margin of the lesion from tissue characterized by atrophic gastritis to a region of malignant, spheroidal cells. These were closely packed, devoid of any acinous formation, and contained excess mucin within the cytoplasm. The investigators noticed the absence of an inflammatory cell reaction and of fibrosis in the periphery of the lesion, and they pointed out that this observation had been the factor which distinguished such lesions from the general changes seen in specimens of peptic ulcers.

In 1934 Henning's book appeared. In it he discussed the relationship of changes in the gastric mucosa to the development of gastric carcinoma, stressing the feeling that gastritis had not received enough attention in this light in the past. He stated that although the question of whether the inflammation was primary or secondary remained to be answered, detection by Konjetzny and Saltzman of gastritis in specimens of cancer had to be given prime consideration. He was convinced that Ménétrier, Nauwerck, Verse, and other investigators had demonstrated the connection between gastritis and malignant tumors.

Henning credited Hauser, Ménétrier, Lubarsch, Verse, and Konjetzny with demonstrating that the atypical gastric gland and epithelial elements, preceded by the chronic inflammation, followed atrophy within the structure of the stomach. Henning recalled

that on the basis of microscopic study of tissue affected by chronic gastritis, the ostensible site of origin of the malignant degeneration was in the luxuriant overgrowth of the lining epithelium, as well as in the heterotopic glands.

Henning quoted Orator's observation that the gastritis associated with cancer was of the atrophic type and that it was spread diffusely throughout the entire stomach, in contrast to the type of gastritis accompanying peptic ulcer, in which it was circumscribed and more frequently than not confined to the pyloric antrum. Furthermore, Henning wrote, Konjetzny had pointed out that the peculiar distinction of the gastritis associated with carcinoma was the excess activity of mucus-producing cells (in contradistinction to the mere acute and subacute inflammation accompanying the usual type of peptic ulcer).

Henning held that evidence of atrophy was observed in specimens of tissue affected by carcinomatous gastritis, although the atrophy was not so diffuse or extensive in some cases as it was in others. The significant changes in the mucosa were disclosed by the remaining glandular cells. Hand in hand with the loss of specific epithelium, regeneration was detected as operative within the mucus-producing cells. Therefore, the most spectacular characteristic change observed in Henning's sections of mucosa affected by gastritis accompanying carcinoma was the luxuriant overgrowth of the lining epithelium. The shapes of the thick lining cells varied from round to polygonal. The nuclei appeared to have migrated to the bases; pyknosis was a common characteristic. At times, mitotic figures were seen. A prominent change was the piling up and thickening of the basement membrane. This scarcely had been mentioned before the emphasis accorded it by Konjetzny.

Henning concluded that the pathological picture was heterotopia of the gastric glands, overgrowth of the interstitial network, and "infiltration" (mostly by lymphocytes but also by plasma cells). In some cases, the greatest change occurred in the immediate vicinity of the tumor, but in any event the most pronounced gastritic lesions were seen in the carcinomatous mucosa.

Early in 1935, Simpson analyzed 52 specimens taken for biopsy from cancerous stomachs. Varying degrees of gastritis were seen in all the specimens and suggested to him that the condition preceded, rather than followed, the cancer. Nearly all the specimens of gastric tissue exhibiting well developed atrophic gastritis he had ever seen had come from carcinomatous stomachs. In those instances in which the cancers were held to be secondary to the formation of ulcers, the gastritis was much less severe and was restricted to a region close to the edge of the tumor. Fifty per cent of the cancers were associated with some free acid; all the "ulcer-cancers" were associated with free acid.

Faber followed the course of the term "gastritis" through its early acceptance as a diagnosis and its later abuse and disrepute. His thorough and clarifying reports have done much to re-establish proper consideration of the condition of the term. In 1935, he (5) reported that by the intra-abdominal injection of from 400 to 500 cubic centimeters of a solution of 10 per cent formalin immediately after the death of patients, good fixation was realized. The specimens thus prepared were free from postmortem gastromalacia and destruction of the gastric epithelium. Faber clearly described two types of gastritis as encountered pathologically; namely, the erosive type and the chronic diffuse type. He observed that cysts might form in the crypts; lymphocytic aggregations near the pylorus in chronic cases led to the adoption of the term "chronic follicular gastritis." Hypertrophy of the surface epithelium and that of the epithelium of the crypts might raise folds and warty protrusions (polyps), which constitute a form of end product of the atrophic inflammatory process. In most places, Faber said, metaplasia occurs; the surface epithelium, formerly typically gastric, is transformed into goblet-cell epithelium. The gland-bearing region then resembles a gland-bearing region of the small intestine. Faber pointed out that the final stage of chronic gastritis may be pronounced atrophy of the mucosa.

Concerning the relationship of gastritis to achylia, Faber declared that anacidity is usually the result of a disturbance of the mucosa,

a disturbance which is gastritis in some form. The scale of anacidity corresponded well with the range of anatomical changes, and it was not considered a constitutional defect. Hereditary and constitutional factors were said to enter only as they affect the power to ward off gastritis. Faber concluded that "cancer is always accompanied by gastritis." He suggested that regenerative changes might be of pathogenic importance. He stressed the point that no matter what other factors enter the discussion, predisposition to cancer in the form of heredity and constitution cannot be overlooked.

In 1936, Duplant published results of histological studies of the carcinomatous gastric mucosa made at varying distances from the edge of the tumor. He found that both close to the edge of the lesion and at a distance from it there was tissue involved by superficial and deep gastritis with layers and islands of round cells. Neoplastic cells were not seen at a distance; the tumor seemed limited to the carcinomatous region. Varying degrees of intensity of inflammation were observed in tissue from various stomachs and this inflammation was obvious at a distance from the tumor.

Hurst (9) then declared that he considered gastritis to be the only common primary disease of the stomach; he said that "the prevention of gastritis would mean the prevention of chronic gastric and duodenal ulcer and of cancer in the stomach." He held that if the stomach were protected from the "extrinsic factors" of alcohol and dietary abuse, carcinoma would not develop. The "intrinsic factors" were said to be hereditary and constitutional factors. He was certain that gastritis produces achlorhydria and that it also produces carcinoma. He repeated the contention that gastric cancer might be expected to develop among many patients having pernicious anemia, since the life expectancy of patients with the latter disease has been prolonged. He concluded that cancer never develops in a healthy stomach.

Also in 1936, in a review of 158 resected carcinomatous stomachs, Tuomikoski outlined the conditions most suggestive of atrophic gastritis acting as the primary disease; mucosal changes were no more prominent close to the edge of the carcinoma than they were at a distance from it; the incidence and intensity of gastritic changes were independent of the nature of the carcinoma; such marked changes obviously required a long time to develop. Tuomikoski concluded that "Most carcinomas of the stomach probably arise on the basis of a chronic atrophic gastritis."

Baker approached the problem from its chronological aspects: in the antrum of the stomach, the early changes were increase in stroma and addition of lymphocytes; later, lymphocytes gathered in the form of follicles; still later, atrophy appeared in the specific epithelial cells, and at times there was apparent hyperplasia of the epithelial cells. In cases in which the process was more advanced, the epithelium had the appearance of intestinal epithelium, with "goblet cell metaplasia," as European workers called it. In all cases the muscularis mucosae appeared thickened by fibrosis and hypertrophy, and lymphocytes frequently were present. In the corpus the changes were as described, and the dominant feature was atrophy, partial and sometimes complete, of the chief and parietal cells.

In 1937, gastroscopy entered into wider use. The types of gastritis recognized by Schindler, Ortmayer, and Renshaw were superficial, atrophic, and hypertrophic. They concluded that gastric carcinoma might follow the atrophic type of gastritis.

In the same year, one of the most significant of all these analyses made its appearance. Comfort, Butsch, and Eusterman reviewed observations made of 79 patients having carcinoma of the stomach for whom gastric analysis had been carried out before the clinical appearance of carcinoma. Of these, 30 patients (38 per cent) had had achlorhydria at the time of the original aspiration. Forty-seven patients (59 per cent) had suffered from cancer of the stomach within the next 5 years and 20 more within the next 5 years.

These authors stated that "The process responsible for the reduction of gastric acidity attacks the mucosa in some cases but not in others." They favored the hypothesis that destruction had occurred in the secreting cells previous to malignant changes. This process

probably had the nature of gastritis. Quoting Baker, who had examined tissue from patients who underwent gastric resection, they reported: (1) in the stomachs having no free acid at the first aspiration, the mucosa of the upper antrum and lower corpus disclosed marked atrophic gastritis and very few acid-secreting cells; (2) in the stomachs with free acid present at the original aspiration but none at the second test, the mucosa of the upper antrum and lower corpus disclosed moderate or marked gastritis and only a few acid-secreting cells; and (3) in the stomachs with some free acid present at all aspirations, the mucosa revealed slight to moderate gastritis. Three stomachs had normal mucosa.

Comfort and his co-workers believed that it was conservative to claim that the loss of gastric acidity usually took place before the onset of malignant neoplasm.

In 1939, Robertson presented a paper in which many ideas were crystallized. Previously he had concluded that the most frequent lesion in the superficial layers of the mucosa of the stomach was hemorrhage. In 1939 he elaborated on a possible subsequent course of the hemorrhage. Hemorrhage was said to lead to necrosis, and digestion of the necrotic region, to ulceration. Ordinarily, he wrote, the ulcerated regions heal completely. Grossly, the mucosa may seem to be restored, but in some instances microscopic examination reveals residual lesions in it. These he listed as collections of lymphocytes in the mucosa, irregular thickening and fibrosis of the muscularis mucosae, atrophy of the chief and parietal cells, hyperplasia of the mucous cells, and disorganization of glandular elements.

Robertson anticipated two main objections to his list. First would be the question, what is the significance of the lymphocytes; does each collection represent an old ulcer? To this he replied that facts at his command insufficiently supported such an assumption. Second, would be the question, what of other causes of ulceration, such as embolism and thrombosis? He stated that there is no fundamental difference; that the first lesion in most cases of gastric ulcer is hemorrhage from the capillaries of the mucosa. The disintegration and necrosis are merely subsequent developments. One of the conclusions reached was that "the hyperplasia of the mucous glands may have some relation to the development of carcinoma."

Robertson's work throws new emphasis on early individual deviations from the normal state within the gastric mucosa. Many other workers have added valuable isolated contributions to the study, but the majority of the investigations centered upon or took issue with gastritis. Long standing lesions of the gastric mucosa have been neglected. The greater share of the research has not been initiated at the primary point of importance.

MICROSCOPIC INVESTIGATION

The aim of the present study was to investigate the residual lesions present in the gastric mucosa long before gastritis as described by some authorities could be diagnosed.

Material. The material examined consisted of specimens from 200 carcinomas of the stomach removed at operation, necropsy, or both. The patients were encountered at the Mayo Clinic between 1926 and 1938. Their average age was 58.7 years; the youngest was 16 years old and the oldest, 83 years. There were 154 males and 46 females.

Sections made for microscopic examination were divided into two series. The first series consisted of sections taken directly through the carcinoma and is designated "tumor series." The second group of specimens was cut at a standard distance of 10 centimeters from the edge of the tumor and is designated "remote series."

As a control, 78 average stomachs were examined. These were obtained at the routine postmortem examination of patients who had been known not to have carcinoma of the stomach. Since the majority of specimens in the series concerned with carcinoma came from patients who were more than 35 years of age, the age of 35 years was taken arbitrarily as a dividing point. Thirty-nine specimens in the control group came from patients who were more than 35 years old. Their average age at death was 55.3 years. Twenty-eight were males and 11 were females. This subgroup is designated the "comparable-age control series."

The other 39 specimens came from patients who were less than 35 years of age. Their average age was 18.2 years. Twenty-two were from males and 17 from females. These are to be known as the "younger control" series.

Method. Since the residual lesions mentioned previously are those most constantly observed in the diseased gastric mucosa, that list was employed herein as a thorough and convenient criterion for estimation of previous damage. This list has been modified in regard to the muscularis mucosae. It was noticed that thickening, irregularity, and fibrosis of the layer might occur singly or in various combinations. Therefore, for convenience in tabulation, the residual lesions were placed in seven separate columns: (1) lymphocytes; (2) irregularity of muscularis mucosae; (3) thickening of the muscularis mucosae; (4) fibrosis of the muscularis mucosae; (5) atrophy of the chief and parietal cells; (6) hyperplasia of the mucous cells; and (7) disorganization of the mucosal glandular elements.

All the microscopic sections were examined from the standpoint of this list. The degree of the change observed was tabulated on the usual grading scale of 1 through 4, in which 1 indicates the least, and 4 the greatest, change.

Results. In the 200 cases of carcinoma not one case could be placed entirely outside the seven columns of classification, although a few sections cut through the tumor revealed little evidence of the lesions. Likewise, all the specimens of the remote series contained evidence of at least one of these lesions. At the same time, the comparable-age control series had only 1 completely free member. The younger group contained 4 such instances.

When the final tabulations of the grades of change were examined closely it became apparent that certain of the "residual lesions" could not in themselves be regarded as of prime significance in the development of the carcinoma. To elaborate, the most common change in all specimens, whether cancer or control, was the accumulation of lymphocytes in the mucosa, either in so called follicles, or in diffusely scattered array. There was no consistent relationship either as to number or degree, and it is true in this regard as well as in the study of any tissue that adequate proof of the exact significance is lacking. Then, too, part of the observed irregularity and thickening of the muscularis mucosae was seen to be secondary to the presence of the carcinoma in many sections. These two changes, associated with fibrosis of the muscularis mucosae, also were rather common in the noncarcinomatous control stomachs, especially of the comparable-age group. "Disorganization" was obviously too nonspecific.

The evidence obtained by tabulation of the grade of change in the 5 residual lesions considered of secondary importance in the pathogenesis of carcinoma was later found to be invaluable in the study of chronicity of disease, of which more will be said hereafter. This leaves for serious primary consideration only two of the residual lesions, namely, (1) atrophy of the chief and parietal cells, and (2) hyperplasia of the mucous cells.

Frequency of the lesions. Atrophy of the specialized epithelial cells was an extremely frequent and consistent observation in the cancer group, both in the sections made directly through the tumor, 98.5 per cent, and in those cut at the standard distance of 10 centimeters from the edge of the cancer, 91.5 per cent. Only a slightly less frequent appearance of hyperplasia of the mucous cells was recorded in these two groups, 89.5 and 83.5 per cent respectively. On the other hand, in the control groups, these findings were much less common: atrophy in the comparable-age group was only 66.6 per cent, and in the younger control group 48.7 per cent; hyperplasia in the comparable-age group was 33.3 per cent, and in the younger control group 30.7 per cent.

Prominence of the lesions. The comparative degree of severity of change was next examined on the grading scale of 1 through 4. To eliminate all questionable factors, such as slight or debatable change, personal bias, and other possible elements, a separate tabulation was drawn up to demonstrate only the significant degree of change. The incidence of atrophy of special cells of grade 2 plus or higher was 81 per cent in the tumor series, 58 per cent in the remote series, 25.6 per cent in the comparable-age series, 12.8 per cent in the younger control

series. The incidence of hyperplasia of mucous cells of grade 2 plus or higher was 44 per cent in the tumor series, 35 per cent in the remote series, 5.1 per cent in the comparable-age control group, and 5.1 per cent in the younger control group. The fundamental differences between carcinomatous stomachs and control stomachs as brought out by this study are summarized bluntly. To obtain a complete view of the prominence of the significant residual lesions, the average degree of change by grades was computed on the numerical basis as follows: atrophy of special cells graded 3 minus in the tumor series, 2 plus in the remote series, 1 in the comparable-age control group, 1 minus in the younger control group; hyperplasia of the mucous cells graded 2 in the tumor series, 1 plus in the remote series, 1 minus in the comparable-age control group, and a little above 0 in the younger control group.

Atrophy and regeneration. On the numerical basis it would appear highly important to consider the hypothesis that the process of atrophy of the chief and parietal cells initiates an attempt at repair in the form of hyperplasia of the mucous cells. Apparently, control of this hyperplasia is lost and malignant growth results. The consistently higher grade of hyperplasia in specimens from the tumor series compared to that seen in the remote series of specimens from the same stomachs is interpreted to imply that at some time a definite change from the process of simple hyperplasia to that of actual carcinoma occurs. The consistently lower incidence and markedly less prominent degree of hyperplasia in the control groups lend support to the conclusion that hyperplasia (regenerative activity) is a highly important factor in the pathogenesis of carcinoma of the stomach.

Gastric acidity. The many references in the literature to achylia and its possible importance, together with the conclusions of Comfort, Butsch, and Eusterman concerning gastric acidity before and after the development of carcinoma of the stomach, stimulated a similar review in this series. Of the 200 cases of carcinoma, gastric analysis was recorded in 124. Of these, in 96 cases (77.4 per cent) there was no free acid. The average amount of free acid was 5.37 "points." The close correlation of this figure with the high degree of atrophy of the parietal cells already recorded is obvious.

Of the 200 cases, in 20 the neoplasm was suspected clinically of originating as a gastric ulcer. Eighteen males and 2 females were concerned. The average age was 57.8 years. Gastric analysis was recorded for 18; free acid was present in every one of these cases. The average free acid was 28.7 "points." This so called ulcer group was separated from the main series temporarily, and a comparison of the significant criteria made as follows: atrophy of the special cells graded 3 minus in the tumor series, 1 plus in the remote series; hyperplasia of the mucous cells graded 2 minus in the tumor series, 1 plus in the remote series. Comparison of the figures suggests that the major difference between the entire cancer series and the "ulcer-cancer" group, in regard to degeneration and attempted repair, is the generally lower average grade of atrophy in the remote counterparts of the latter group. If these "former ulcer" cases could be disregarded, it would seem that an excellent clinical indicator of the ability of the stomach itself to ward off the development of carcinoma would be the presence of a normal amount of free hydrochloric acid. Can gastric mucosa which is maintaining normal acidity be assumed to sustain no degeneration and therefore to initiate no disorganized attempt at repair? As yet there is no clinical indicator of the status of the mucous cells.

EVALUATION OF STUDY

The time factor. With reference to those residual lesions which were considered to be of secondary significance in this study, it is worth while to regard the control cases from the chronological viewpoint. The stomachs of the patients of infancy and childhood years were found to demonstrate the fewest and least marked residual lesions and therefore were considered to be the most nearly normal. On the other hand, among patients between 30 and 50 years of age, varying degrees and combinations of the residual lesions as a rule were observed. Although specimens from some of the oldest patients disclosed very little damage, numerous stomachs from patients

past 50 years of age revealed many of the changes, in a very marked degree. It seems conservative to state that the average young person is likely to be more free from gastric changes than is the average old person.

In the younger control group, the observed lesions were usually of the less significant type; they were lymphocytes, general mucosal disorganization and incidental thickening. Atrophy of the special cells and hyperplasia of the mucous cells were rare. The comparable-age control patients revealed much more marked irregularity, fibrosis, and thickening of the muscularis mucosae, with some diffuse atrophy of specialized epithelium. These features all point to a decidedly chronic condition.

In the carcinomatous stomachs, the most significant lesions were those discussed above. In addition to these there was a high degree of change in the muscularis mucosae, arguing for a long standing disease process. These factors had been emphasized previously by Baker and by Robertson. There is a strong suggestion that chronic atrophy of the chief and parietal cells is a persistent stimulus to the production of disorderly hyperplasia of the mucous cells. Faber (5) touched on this when he hinted that certain reparative processes might be of importance in pathogenesis of gastric carcinoma.

The early work of Lebert, later elaborated upon by many others, stressed the importance of a generalized mucosal change. In the present study, the discovery of certain similar, significant lesions in the mucosa 10 centimeters from the edge of the carcinoma suggests that the entire stomach is host to the malignant process. The change is gradual and diffuse and is not a sudden, primary overgrowth. All present observations tend to indicate that the mucosa begins to change long before the actual appearance of carcinoma. It will be recalled that Henning, Steinberg, Tuomikoski, and others held the same opinion. Simpson observed somewhat similar changes which he called "gastritis," and he asserted that the remote counterparts of "ulcer-cancer" cases exhibited much less general change than other types of carcinoma.

Faber (4, 5) commented on the close correlation of gastric anacidity with the observed range of anatomic gastric changes; this correlation agrees with the present observations. Also, the clinical work of Comfort, Butsch, and Eusterman, together with the study from the pathological viewpoint of their cases by Baker, tends to substantiate the general assertions made herein. The fundamental difference between the average carcinomatous stomach and the average noncarcinomatous stomach is the relative lack of mucous-cell hyperplasia in the latter.

It would seem that Hurst (9) expressed much in few words when he declared that carcinoma does not develop in a healthy stomach. Thus far, the most important factors in the development of carcinoma of the stomach appear to be: (1) many years of repeated anatomic insults, resulting in residual lesions and disorganization of the reparative processes, (2) age, and (3) heredity.

SUMMARY

Review of the literature reveals many attempts to designate gastritis as a precursor of gastric carcinoma.

Residual lesions of ulcerative gastritis are defined as "irregular thickening and fibrosis of the muscularis mucosae, atrophy of the chief and parietal cells, hyperplasia of the mucous cells, and disorganization of the mucosal elements."

A study made microscopically of sections from 200 carcinomatous stomachs and of sections from 78 control stomachs is outlined.

The frequent occurrence of certain residual lesions in carcinomatous stomachs is compared to the occurrence of such lesions in noncarcinomatous stomachs.

Evidence is presented to indicate that essentially similar lesions occurring at a distance from a gastric carcinoma suggest that the entire gastric mucosa has undergone change and that much time has been required for this change to take place.

The fundamental difference between the average carcinomatous stomach and the average noncarcinomatous stomach is the relative lack of mucous-cell hyperplasia in the latter.

CONCLUSIONS

Carcinoma develops in a previously damaged stomach.

Many years of such injury may be required before neoplastic transformation begins.

The pathogenesis of gastric carcinoma is directly related to the disorganized hyperplasia of gastric mucous cells.

REFERENCES

1. Baker, C. P. Proc. Mayo Clin., 1936, 11: 521–522.
2. Comfort, M. W., Butsch, W. L., and Eusterman, G. B. Proc. Am. Gastro-Enterol. Ass., 1937, pp. 45–53.
3. Duplant, F. Lyon méd., 1936, 157: 459–466.
4. Faber, Knud. Lancet, 1927, 2: 901–907.
5. Idem. Gastritis and its Consequences. London: Oxford University Press, 1935.
6. Friedenwald, J., Morrison, T. H., and Morrison, S. Internat. M. Digest., 1935, 26: 119–124.
7. Henning, Norbert. Die Entzundung des Magens. Leipzig: J. A. Barth, 1934.
8. Hurst, A. F. Lancet, 1929, 2: 1023–1028.
9. Idem. Gastritis. Guy's Hosp. Gaz., Lond., 1936, 50: 227–237.
10. Konjetzny. Quoted by Henning, Norbert.
11. Orator. Quoted by Henning, Norbert.
12. Plummer, N. S., and Simpson, C. K. Guy's Hosp. Rep., Lond., 1931, 81: 407–417.
13. Robertson, H. E. J. Am. M. Ass., 1939, 112: 22–27.
14. Schindler, Rudolf, Ortmayer, Marie, and Renshaw, J. F. J. Am. M. Ass., 1937, 108: 465–468.
15. Simpson, C. K. Guy's Hosp. Rep., Lond., 1935, 85: 102–125.
16. Steinberg, M. E. Arch. Surg., 1927, 14: 991–1022.
17. Tuomikoski, Viljo. Acta chir. scand., 1936, 78: 251.

THE SHOULDER JOINT—OBSERVATIONS ON THE ANATOMY AND PHYSIOLOGY

With an Analysis of a Reconstructive Operation Following Extensive Injury

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THE primary purpose of this report is to present certain observations which have radically altered our conception of the basic anatomy and physiology of the shoulder joint. This is the result of a combination of clinical experiences checked by anatomical dissection.

These changes have necessitated revision of our ideas concerning etiology, pathology and treatment of diseases which affect the shoulder joint. This shift is not limited to traumatic lesions alone but extends to include many congenital and acquired complexes.

A reconstructive operation for the shoulder joint following fracture or injury about the head of the humerus will be presented, not only for the intrinsic value it may possess, but as an illuminating experiment in the pathological physiology of the shoulder joint. In short, these observations concerning basic anatomy and physiology were made in the course of attempting to explain variable postoperative results.

This procedure was first reported in 1933 (2). At that time it was demonstrated that following resection of the head of the humerus, a stable shoulder could still be secured by transplanting the "short rotators" into the upper end of the shaft.

It was to be used following fracture dislocation of the head, severely comminuted fractures in this region which defied reduction, or when it was necessary to remove the head for other reasons. This original article suffered from an inadequate presentation due to the fact that the author did not understand, at that time, these basic principles which seem to govern the shoulder joint. Aside from these considerations, the procedure has been of value in civil practice and should have considerably more use in military surgery.

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In the belief that interest will be increased by following the chronological development of these ideas, the presentation will start with the first case history.

CASE 1. July 15, 1926, a man engaged in the building trade, aged 67 years, fell a distance of about 10 feet from a scaffold and in so doing struck the left shoulder heavily against a timber. He was immediately taken to the hospital and it was noted that the left shoulder was flattened as compared with the other. Without a preliminary roentgenogram, dislocation was diagnosed by the surgeon. He was placed under anesthesia, and a vigorous attempt made at reduction. When deformity was still found to be present, roentgen examination was made and the patient was found to have a comminuted fracture just above the surgical neck with subglenoid dislocation of the head. Six separate fragments could be seen. It was an interesting picture. Now it can be told that it was so interesting that it shortly disappeared, and therefore cannot be reproduced.

Because of the wide separation of fragments, there was complete agreement that resection of the dislocated head and fragmented tuberosities was clearly indicated and that without doubt the end-result would be a "flail shoulder." To avoid this the author agreed to attempt an experimental procedure, which he had been considering for some time.

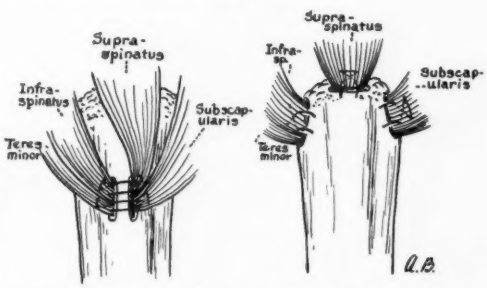

Fig. 1. Illustrating differences in the sites of transplanted capsular muscles that form the basis of the reconstruction that follows resection of the head of the humerus. Left, Case 1, typical location that resulted in complete stability, return of normal range of motion with good muscle power. Right, Case 2, reposition that followed anatomical description resulting in complete stability accompanied by limited range of motion and decreased muscle power.

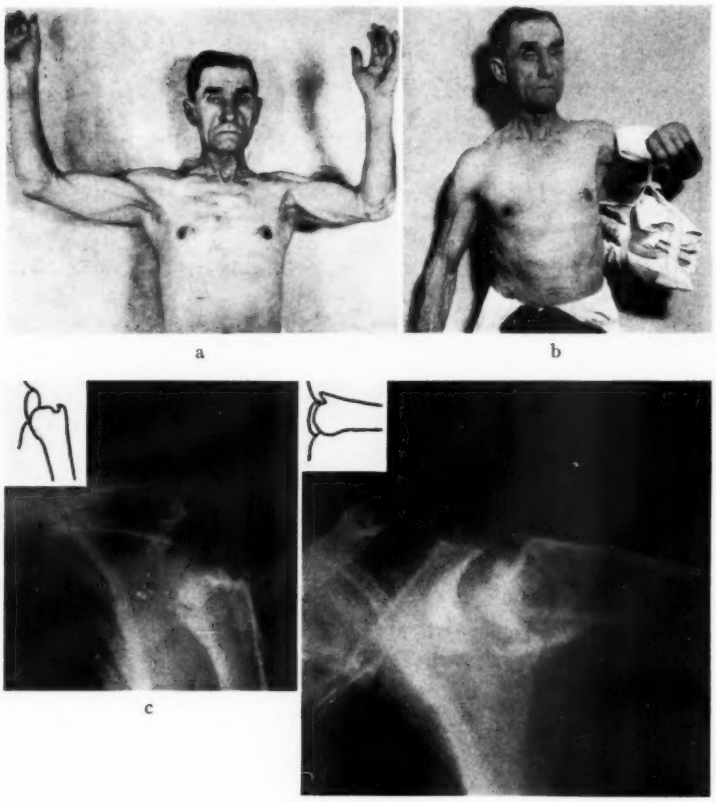

Fig. 2. Photographs taken 3 years after the operation illustrating the final result. a, Return of approximately normal range of motion; b, return of good muscle power, carrying 30 pounds in full abduction; c, roentgenograms and tracings with arm at the side, showing defect occasioned by loss of head; d, roentgenograms and tracings showing ability of transplanted muscles to obliterate defect and stabilize shoulder joint. Note the reformation of the rudimentary head.

The operation itself will be described later in detail. Summarizing, the dislocated head and fragmented tuberosities were removed, meanwhile carefully preserving the tendons of the "short rotators." The upper end of the shaft was rounded. In the hope that some measure of shoulder stability would be given to the headless humerus the "short rotators" were transplanted into two slots on the lateral surface of the humerus.

At the end of 6 months the patient was able to return to active work in the construction industry. He lived for 15 years after the original operation, had a completely stable, painless shoulder, with practically a complete range of motion. He was able to carry 30 pounds of sand bags with arm at a 90 degree angle, in full abduction. Accompanying photographs and roentgenograms taken 3 years later show this.

The roentgenograms and tracings are of special interest. With the arm at the side, they show a headless humerus with the upper end lying just above the lower margin of the glenoid. Without further knowledge, one would say that dislocation in abduction would be inevitable. The next tracing and roentgenogram show that, in abduction, the transplanted "short rotator" muscles pull the shaft of the humerus snugly into the glenoid. A rudimentary head has reformed on the inner surface of the shaft (Figs. 1 and 2).

It did not take long after the first operation for all of us to realize that we were dealing with an unexpected phenomenon. This did not happen because "we planned it that way." Shoulder stability alone would have been considered very satisfactory, but the final result showed that in addition to complete

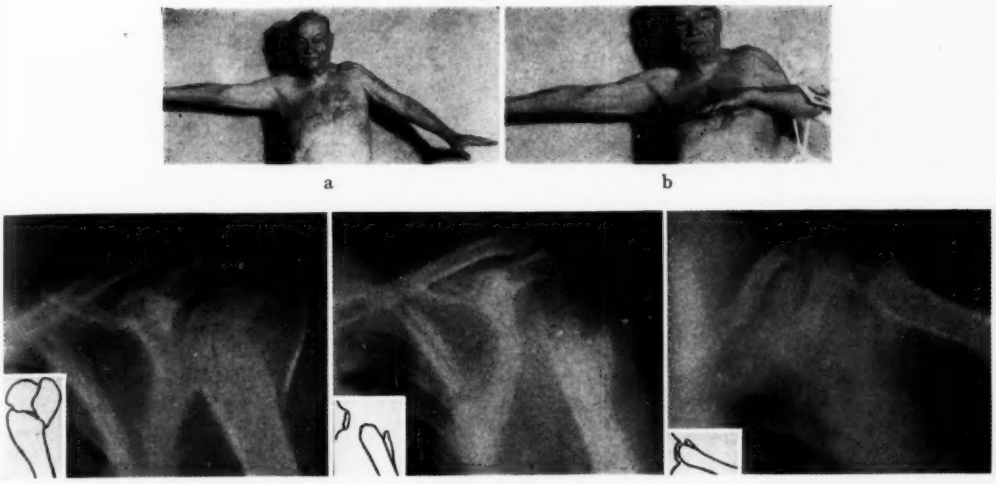

Fig. 3. Photographs taken 2 years after operation. a, Stable shoulder with decreased range of motion; b, stable shoulder with only fair muscle power; c, original roentgenogram and tracing showing extreme comminution and displacement of fragments; d, roentgenogram and tracing, with arm at side, after resection of the head and reconstruction; e, roentgenogram and tracing with arm in abduction, demonstrating the ability of the transplanted muscles to close the defect and to stabilize the shoulder joint.

stability, there was almost a complete restitution of shoulder function.

In the old operation the head was resected without any treatment of the shaft. In the new, certain muscles were transplanted into the upper end of the humerus. Therefore, this procedure seemed to be the difference between two very different end-results, one, a "flail shoulder," the other, a shoulder having excellent function.

In retrospect, it is now seen that the end-result in the first case is all that could possibly have been expected. But this was not seen at the time, as convalescence was slow. To secure a complete range of motion, several manipulations were necessary. It was thought that this was due to the fact that the site of the insertion of the transplanted "short rotators" did not conform to the usual anatomical description. In the next case, the sites were changed (Fig. 1).

CASE 2. October 16, 1930, the patient, a mechanic for the city water department fell a distance of about 10 feet from a ladder. He believes that he fell directly on the point of the left shoulder. He was 58 years old, not particularly robust, in considerable pain and slightly shocked. The curve of the left shoulder was flattened as compared with the right and he was unable to move the arm at the shoulder joint. A roentgenogram demonstrated a comminuted fracture of the upper end of the left humerus at the junction of the head and neck. The greater tuberosity was also comminuted. The upper end of the shaft was displaced into the axillary space. Under gas-oxygen anesthesia, reduction was attempted. A plaster cast was applied in which was incorporated a metal device for extension of the arm in partial abduction.

The laboratory reported a strongly positive Wassermann with a slight secondary anemia and a moderate leucocytosis. He was immediately given suitable antiluetic therapy.

Other attempts at reduction, both by manipulation, increasing traction, and changes of splint position, were ineffectual. With supportive measures and antiluetic therapy, his general condition improved. November 14, 1930, a resection was performed, similar in all respects to that described for the first case, with a single difference. The "short rotators" were inserted into the upper end of the shaft, to accord with anatomical description, the subscapularis in front, the supraspinatus laterally, and the joined tendons of the teres minor and infraspinatus, posteriorly.

The postoperative course was somewhat stormy. His secondary anemia became grave, finally resulting, November 25, in a 50 per cent decrease. With blood transfusions and antiluetic therapy, his condition rapidly improved. He was discharged from the hospital in January, 1931. In the end he

was only able to abduct the arm to an angle of 50 degrees and carry a sand bag, weight of 10 pounds, at a 50 degree angle. Aside from this, rotation was severely limited to about one half the normal range. Patient had a painless, stable shoulder which allowed him to perform light work (Figs. 1 and 3).

The roentgenograms with the arm at the side and in abduction do not differ materially from those in the first case. In both, the defect caused by the loss of the head is overcome when the abducted humerus is drawn snugly into the glenoid. But when function is analyzed, great differences between the 2 cases become apparent.

When the end-result in each case is compared, it is obvious that the first is superior in many respects to the second. Muscle power is far greater, as in the range of motion. Yet, the insertions of the "short rotators" in the second followed the usual anatomical description, whereas in the first they did not.

If progress can be defined as two steps forward and one back, then nothing is to be gained by glossing over medical errors. Frequently they are as instructive as successes. In an attempt to explain this functional paradox, numerous studies were made with results that will be detailed.

Even in presentation of a paper of this limited scope, the question of evolution requires prior consideration. The extremely movable human shoulder girdle has evolved from the relatively fixed and immobile weight bearing animal fore leg. The scapula with its long axis, almost in line with the fore-leg, has rotated until the long axis parallels the spinal column and the arm. The cup shaped glenoid has become flattened. The tibia-like plateau at the upper end of the humerus has become a half spheroid. Intermediate changes of this type can be observed at many places in the animal kingdom. Members of the rodent family, squirrels, beavers, raccoons, etc., have shoulder girdles of considerable mobility and efficiency. The shoulder of the brachiating, tree living ape, is not considered, as on the basis of performance it is apparently superior to the human. Evolution is purposeful, and in this case the purpose is evident, namely, to combine in one organ great mobility for some uses and great strength for others. This dual purpose is physiologically complex.

The shoulder girdle consists of the scapula and the clavicle linked together by a series of ligaments at the acromioclavicular joint, and attached to the body in front only at the sternoclavicular junction. All of its attachments to the costal cage are therefore muscular, with this one exception. Attached to this structure at the glenoid is the upper extremity. The sternal link is a freely movable joint, and the net result is that the shoulder girdle seems to float in the air.

Does it float in the air? It seems to when one watches the flowing, graceful arm and shoulder movements of a conductor leading a symphony orchestra. This is pure movement without the stimulus of effort. There is no need to describe it. It is in every textbook, one muscle adducts the scapula, another elevates it, etc. Is there a difference between these movements and the constrained, limited efforts of a man lifting a piano? Here, the shoulder is at work, capable of lifting fantastic weights. This will be called the reaction to the stimulus of effort.

Hundreds of pounds of weight cannot be lifted on a shoulder girdle that "floats in the air." It must be fixed and stable. As its only significant connections to the costal cage are muscular, then stabilization must occur through muscular action.

The effort stimulus presents many gradations and combinations. The shoulder movements of the athletes, such as pitcher, fighter, and golfer, present preliminary stabilization of the shoulder joint during early effort, followed by a wide range of movement that is actually muscle release. In golf, they speak of this as "follow through."

If effort demands that this joint be stabilized, rendered immobile, then simultaneously the glenoid and the head of the humerus must be fixed. Just as it takes two parties to make a contract, so does it take two joint surfaces to make a joint. One is the glenoid, which belongs to the scapula, and the other is the articular surface of the head of the humerus. Thus, two distinct muscle systems must be involved, those connecting the scapula to the costal cage, and those connecting the head of the humerus to the scapula. Let us attempt to explain the first of these two complexes.

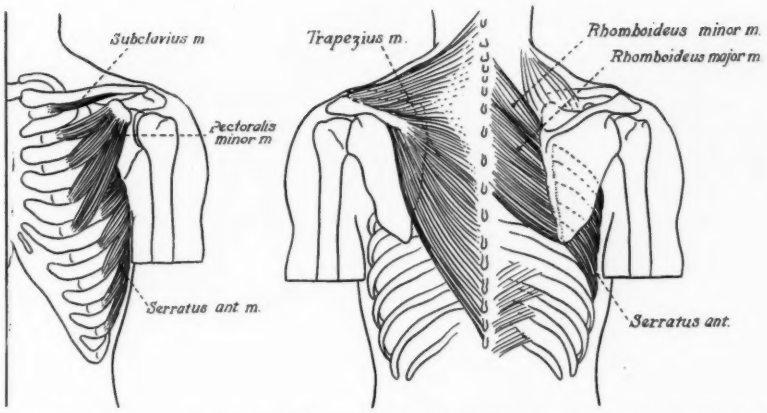

Fig. 4. Diagrammatic representation of the muscle groups connecting the clavicle and scapula to the costal cage. These contract synchronously to stabilize the glenoid, during the effort complex. a, left, The anterior group; b, the posterior group.

This is effected by synchronization of muscles which cause the scapula and clavicle to be pulled firmly against the costal cage. Once this is accomplished, the glenoid becomes a fixed point. The chief muscles effecting this are the subclavius and the pectoralis minor acting as stabilizers anteriorly, the trapezius, major and minor rhomboids, posteriorly, and the serratus anterior, which acts powerfully on the vertebral border of the scapula, although it originates anteriorly (Fig. 4). This combined mechanism resembles the guy ropes of a tent pole in that, if they act simultaneously, they stabilize by counter action.

The second phase of this problem is, namely, stabilization of the articular surface of the head of the humerus, the outer side of the joint, by muscles connecting the scapula and the head. This is accomplished in the presence of severe mechanical disadvantage. That it can be done at all is a triumph of evolutionary adaptation. The upper end of the humerus has become a half spheroid, the "ball" of what is described as a ball and socket joint.

A better description would be that it is a ball without a socket. The fact that the glenoid has become flat, deepened only by a vestigial thin layer of cartilage has been mentioned. All of this is the interest of a completely free range of relaxed motion. But the effort syndrome calls for primary stabilization, firm fixation of this rounded head in a flat glenoid, and this is accomplished by four muscles, usually described as "short rotators." These are actually three, as two of them function as one. These muscles, listing them from before, backward, are as follows: the subscapularis, the supraspinatus, and the infraspinatus teres minor.

Time does not permit us to detail the differences found in the various textbook descriptions of the anatomy and physiology of these muscles. The variance is so great that the truth must be elsewhere. Therefore, it is not to be wondered at that there are grave misconceptions concerning these points, even among orthopedic surgeons. Before the results of certain experiments are given, these muscles will be described as we have come to see them.

This anatomical controversy is chiefly concerned with the insertion of these muscles and the relation of that insertion to the capsule of the shoulder joint. For example, most of the standard textbooks show plates in which these "short rotator" muscles are attached to small areas or facets on the greater or lesser tuberosities of the humerus. Accompanying texts state that they "adhere to" or are "in intimate contact with" the capsule. This anatomical description that follows will start with the much publicized supraspinatus and will show that there is

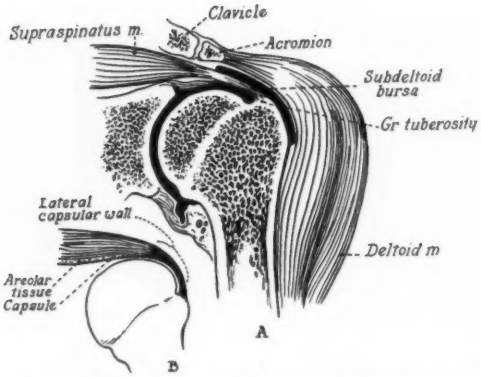

Fig. 5. Diagrammatic cross section illustrating the anatomical interrelation between the head of the humerus, supraspinatus muscle, supraspinatus tendon, capsule, subacromial bursa, and the deltoid muscle. A, Enlarged cross section illustrating the fusion of the supraspinatus tendon and the capsule to form a conjoined tendon before final bony insertion.

considerable variation between these descriptions and factual anatomy.

Before this is done it should be noted that close examination of these areas requires the preliminary removal of the deltoid, the clavicle, the entire acromion process of the spine of the scapula, and the point of the coracoid process with the inserting muscles, the short head of the biceps and the coraco-brachialis (Figs. 5 and 6).

The supraspinatus is actually much smaller than it is thought to be. It arises in the supraspinous fossa and passes over the upper edge of the glenoid. At a point just external to the acromioclavicular junction, it fuses with the capsule to become a conjoined tendon. This conjoined tendon then inserts narrowly into the superior horizontal portion of an inverted "U." This inverted "U" follows closely the margin of the greater tuberosity on the extreme upper lateral surface of the humerus. To simplify surgical anatomy this will be referred to henceforth as the "horseshoe."

The "horseshoe" can be divided into 3 segments: a horizontal plane, an anterior vertical, and a posterior vertical limb. At the points where the horizontal plane turns downward there are two curves, one anterior and the other posterior. At the site of the anterior curve there is an intermuscular hiatus which

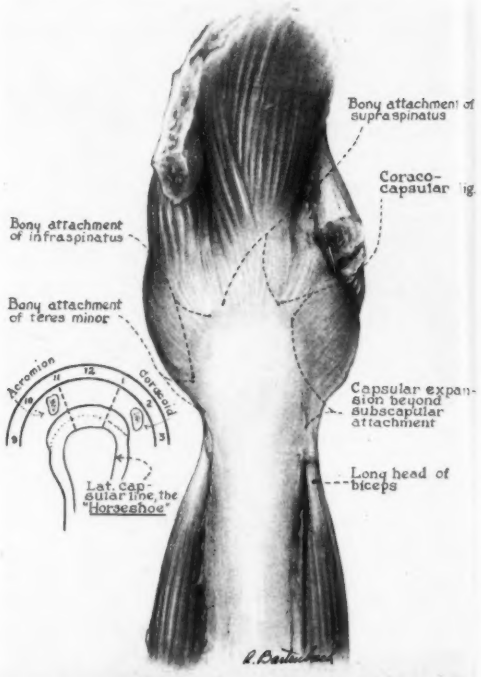

Fig. 6. Lateral view of the shoulder joint. Drawing made from anatomical specimen after removal of the clavicle and the acromion process of the spine of the scapula. Drawing illustrating outline of the greater tuberosity called the "horseshoe" with attachment of the supraspinatus conjoined tendon to the horizontal limb, the subscapularis to the anterior vertical limb, and the infraspinatus teres minor muscle to the posterior vertical limb. In the muscular hiatus between the supraspinatus and the subscapularis, the coracocapsular or coracohumeral ligament. Diagram illustrating these points.

lies between the supraspinatus and the subscapularis capsular components.

In this opening, close to the anterior superior margin of the glenoid, is the base of the coracoid process of the scapula. Springing from this base is a heavy ligament. It spreads fanwise to blend with the capsule. Usually called the coracohumeral ligament, the term coracocapsular would seem more descriptive. This structure grows in functional stature with study and will be discussed in the summary which follows (Fig. 7).

The infraspinatus teres minor are not only anatomically inseparable, but can be considered as one muscle. They arise from prac-

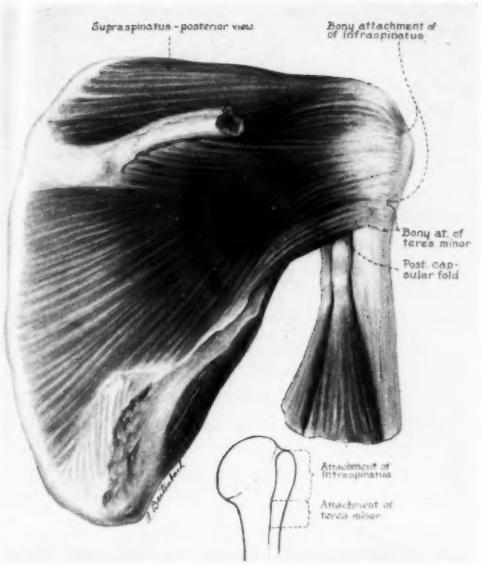

Fig. 7. Posterior view of the shoulder joint. Drawing from the same prepared specimen and diagram. Illustrating posterior view of the supraspinatus muscle and infraspinatus teres minor muscles. Insertion of infraspinatus teres minor conjoined tendon into the posterior limb of the "horseshoe" and the posterior capsular fold.

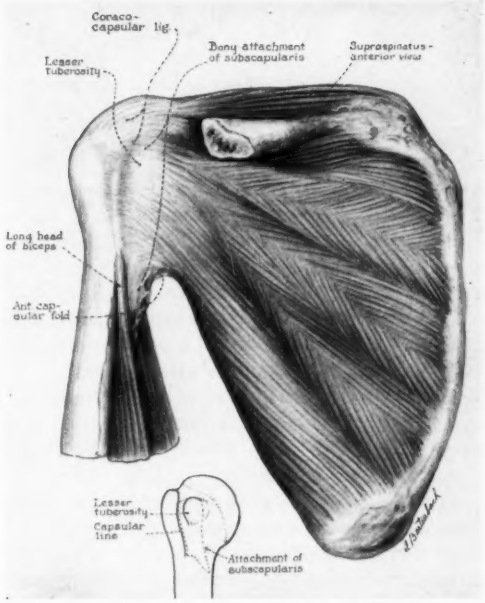

Fig. 8. Anterior view of the shoulder joint. Drawing from the same specimen and diagram, illustrating supraspinatus muscle and conjoined tendon with final insertion into the horizontal portion of the "horseshoe." Coracocapsular ligament. Subscapularis muscle attachment to the lesser tuberosity and to the anterior and posterior margins of the bicipital groove. Final insertion into the anterior vertical limb of the "horseshoe." Anterior capsular fold. Diagram illustrating these points.

tically the entire surface of the infraspinous fossa, to fuse with the posterior portion of the capsule in a manner similar to that described for the supraspinatus. This conjoined tendon occupies the extreme posterior portion of the horizontal plane, the posterior curve, and the posterior vertical leg of the "horseshoe." The lowermost portion of this ends on the posterolateral surface of the surgical neck of the humerus. To this teres minor segment has been given the term the posterior capsular fold. It should be noted that the anterior separation is not duplicated posteriorly. In fact, beneath the recess of the acromion process, the muscle bodies of supraspinatus and infraspinatus are in intimate contact (Fig. 8).

The subscapularis is a thick, powerful, fan shaped muscle, originating from and almost covering the internal surface of the scapula, the subscapular fossa. The muscle fibers converge to become tendinous, just below the acromion process. At this same point the aponeurosis blends with the capsule of the joint to become a conjoined tendon. The superior portion for a distance of about ½ inch is attached to the lesser tuberosity. The remaining portion of the tendon follows the anterior border of the bicipital groove. The lowermost portion ends far down on the surgical neck. This portion is referred to as the anterior capsular fold. The fibers then pass over the long head of the biceps and are again attached to the lateral margin of the bicipital groove to form the roof of the tunnel. There is then a short capsular expansion or prolongation which finds attachment to the anterior limb of the "U" previously mentioned. The fact that the bicipital groove is actually a part of the subscapularis tendon was clearly shown when the subscapularis muscle was excised *in toto*. The bicipital groove was clearly marked as an integral part of the under surface of the subscapularis tendon.

The anatomical description of the deltoid need not be given here. However, it should be noted that the relationship of the deltoid to these capsular muscles follows a regular pattern that varies only with the subscapularis.

Embryological development frequently mirrors evolutionary changes. The deltoid, supraspinatus, and infraspinatus teres minor arise from a common premuscle mass. The subscapularis at first is separated from the other muscles and comes to occupy its final position somewhat later than the others (3).

To complete the anatomical picture, the relation of these muscles as a group to the scapula should be mentioned. When the prepared specimen illustrating scapulohumeral head muscle attachments is viewed from below with the inferior angle of the scapula closest to the eye, one is surprised by the thickness of the scapular muscle envelop. This is further demonstrated in a study of cross sectional anatomy and tends to confirm statements already made and those that follow as to the power of this group of muscles.

There is a general impression that these muscles are small. They are "short rotators" whose function it is to cause internal or external rotation, depending on the muscle in question. They have an added indefinite function, depending on the textbook used, of "re-enforcing" the capsule. The following simple experiment should dispel this fallacy.

From a large, heavily muscled cadaver, the following muscles were excised *in toto* and weighed: The deltoid, the subscapularis, the supraspinatus and the infraspinatus teres minor. At the same time, the biceps, both long and short head, was excised to furnish a basis for comparison. This was done for two reasons: first, because the biceps is a very familiar muscle, and second, the long head has entered into procedures designed to stabilize the shoulder joint. The weights are as follows: the biceps, 121½ grams; deltoid, 391 grams; subscapularis, 191 grams; supraspinatus, 65 grams, and the combined infraspinatus teres minor, 163½ grams. It is recognized that these weights will vary with the size of the individual. When they are taken from the same individual, however, and compared with each other, the proportional weights should not vary greatly. The analysis of these figures is very interesting. It shows that the combined weight of these "short rotators" or capsular muscles was approximately 420 grams.

The combined weight of these muscles was greater than that of the deltoid. They are relatively more powerful than longer muscles in that they work in a very short arc. These findings would tend to show that they are not accessory muscles, but are of prime importance and are extremely powerful.

Summarizing, it would seem probable that these muscles stabilize the head in the glenoid by acting in combination, and in abduction as a unit. A diagram (Fig. 9) was prepared to illustrate this point, and was later found to closely resemble an anatomical cross-section made near the level of the head of the humerus. As is usually the case, however, diagrams tend to oversimplify a problem. The symmetrical anterior and posterior capsular folds would seem to have a specialized function. They should act most powerfully, either together or singly, depending on the anteroposterior relation of the elevated arm to the body.

The portion of the capsule lying between the subscapularis and supraspinatus has been called the coracohumeral, or in this description, the coracocapsular ligament. It probably acts to prevent rotation in the fixed glenoid beyond a 90 degree arc. Movements beyond this point are performed by the entire shoulder girdle moving as a unit.

Before a description is given of the operative technique of reconstruction, the alternative, namely, resection without reconstruction, should be discussed. That alternative is the condition known as "flail shoulder."

It is common knowledge that if the head of the humerus is removed to correct fracture dislocation, unreduced comminuted fractures, or old unreduced dislocation, or for other reasons, a "flail shoulder" is the result. By "flail shoulder" is meant one that is devoid of voluntary muscle control. There is a scarcity of references on this point as doctors usually do not report their tragedies. One writer expressively described "flail shoulder" by saying "the arm is merely a cumbersome appendage swinging laboriously from side to

side, which is from a practical standpoint, practically useless" (1). The head of the humerus is still being excised without further reconstruction. Very recently an excellent orthopedist reported arthrodesing shoulders following complete transverse rupture of the "musculotendinous cuff." An arthrodesed shoulder is better than a "flail shoulder," but it is still far from being a good functional organ.

In military surgery there are reports which would indicate that "flail shoulder" is an exceedingly common occurrence. Nové-Josserand and Tuffier reported several large series of joint resections in 1916. In 1018 resections, there were 237 of the shoulder joint.

The end-results were listed as follows: stable shoulders with fair or limited mobility, 45 per cent; ankylosed, 11 per cent; and "flail shoulder," 38 per cent. In another series of 98 cases, there were 45 per cent "flail shoulders." In free translation, they say that in these cases, function of the shoulder was completely lost, and as a direct result the forearm and hand became useless. Their large series of cases, reported so early in the first World War and the frequency of the condition should combine to cause grave concern. It is reasonable to expect that in the present war, current improvement in projectiles should increase rather than decrease the frequency of shattering fractures about the shoulder joint.

The operative technique of the reconstruction of the shoulder joint will be given in considerable detail, as there have been many modifications since the preliminary report. The operation has been used in carefully selected cases after repeated attempts had failed to secure satisfactory reduction. It is the only satisfactory method known to the author, and time has shown that it is consistently effective. Careful study of two splendid texts concerning orthopedic surgery lists neither this nor alternative procedures. In all, 7 cases have been followed by this and other observers for periods varying from 3 to 16 years. It is worth noting that, functional variation aside, seven consecutive cases finished with stable shoulder joints.

Prior to the operation there are two points that should be noted. A comfortable abduction splint adjusted to a 50 degree angle should be prepared. The patient should be placed on his side and an assistant designated to hold the arm upon which the operation is to be performed. Adequate posterior exposure requires this position, and during the course of the operative procedure, manipulation is essential.

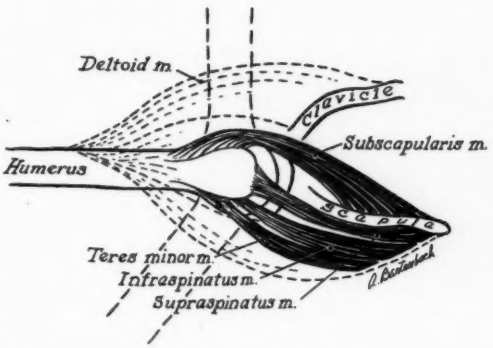

Fig. 9. Diagram illustrating probable physiological action of the capsular muscle group in stabilizing the head of the humerus.

A six inch vertical incision is made on the anterior surface of the arm just below and lateral to the coracoid process (Fig. 10a). It then turns laterally to skirt the acromioclavicular junction, and then passes posteriorly to just below the anterior portion of the spine of the scapula. For further exposure, it may be extended below the spine. The anterior deltoid fibers are separated, retracted, and the subdeltoid bursa is exposed. For proper exposure, the deltoid must be incised following a line close to the acromioclavicular arch. The capsule is opened by the primary "U" incision which follows the margin of the greater tuberosity. It should be noted that this incision, when completed, mobilizes the head of the humerus and gives access to the glenoid.

In the anatomical portion of this report, emphasis has been placed on the exact relation of the insertion of these muscles to the margin of the greater tuberosity or "horseshoe." This has been done to establish a foundation for certain necessary surgical landmarks. At the operating table, instead of a prepared specimen, the surgeon is confronted by an intact acromioclavicular arch, and the smooth,

unbroken lower portion of the capsule. It has been shown that if one divides the "horseshoe" into horizontal, anterior vertical, and posterior vertical limbs there is demarcation of the final point of insertion of the supraspinatus, the subscapularis, and the infraspinatus teres minor, respectively. If, in addition, a scale or clock is mentally superimposed on this intact bony arch, the muscle flaps are visualized (Fig. 10b). A short incision, starting at the anterior curve, is made toward the coracoid process or one o'clock, and another is made starting at the posterior curve toward the acromion, or eleven o'clock. With this, two of the three conjoined tendons of the capsule are immediately separated into their respective parts and mobilized without further treatment. These are the supraspinatus and the infraspinatus teres minor. In comminuted fractures, in which the lesser tuberosity is usually fragmented, the upper portion of the subscapularis flap is likewise partially mobilized by the very existence of this fracture.

When it is not, or when varied surgical procedure requires the mobilization of a subscapularis flap, it must be separated above by an osteotome from its bony attachment to the lesser tuberosity, and below, by sharp dissection from the bicipital groove.

The infraspinatus and the subscapularis flaps are completed by anterior and posterior transverse incisions made at the base of the "horseshoe." It has been considered advisable not to go beyond this base, thus preserving, intact, the anterior and posterior capsular folds (Fig. 10c).

The fractured head is removed (Fig. 10d). The conjoined tendon flaps are secured with clamps and drawn into the wound (Fig. 10e). Comminuted fragments which are still attached to them are separated at this time. The end of the shaft of the humerus is rounded and smoothed. On the lateral surface of the bone, about 1½ to 2 inches from the rounded end, two parallel grooves are made. These should be long enough to fit the prepared flaps. Another similar groove is made just above these and at right angles, and drill holes are made at the ends of each groove. In short, the general configuration of the "horseshoe" is re-established on the upper lateral surface of the shaft. Figure-of-eight silk sutures are now placed in the ends of each of these tendons (Fig. 10f).

The sutures and the tendons of the supraspinatus are placed in the upper groove, the subscapularis in the anterior vertical groove, and the conjoined tendons of the infraspinatus teres minor in the posterior vertical groove.

Then the silk ligatures are anchored, according to the desires of the operator. Suture of the margin of these tendons, the under surfaces of which are lined by serous membrane, is all that is necessary to re-establish the capsule of the shoulder joint. The arm is placed in 50 degrees abduction, and these tendons are adjusted to be taut without tension at this angle. The wound is closed in layers and the previously prepared abduction splint applied.

EVALUATION

In any group discussion of shoulder joint stability, the question as to the relative importance of the long head of the biceps is quickly introduced. Cadaver experiments, which can be easily repeated, will demonstrate that section of the "short rotators" or capsular muscles as they fuse with the capsule, completely disrupts glenohumeral head contact. These are the primary stabilizers. There are many secondary stabilizers and of these the most important would seem to be the muscles attached to the coracoid process, the short head of the biceps and the coracobrachialis.

One notes, everywhere, the profound influence that the works of the late Dr. E. A. Codman have had on the medical thought on this subject. This is as it should be, but there has been too much emphasis on supraspinatus injury, and the importance of the supraspinatus muscle. It has been shown to be the smallest of the three capsular components. It will continue to receive much attention, just as does the frail member of a set of triplets, the one that is frequently sick or injured.

This supraspinatus overestimate has led to the synergistic deltoid-supraspinatus theory (Watson-Jones). This maintains that firm fixation of the humeral head in the glenoid by the supraspinatus is a prerequisite to deltoid function, and followed the observation that abduction could not be initiated after a "com-

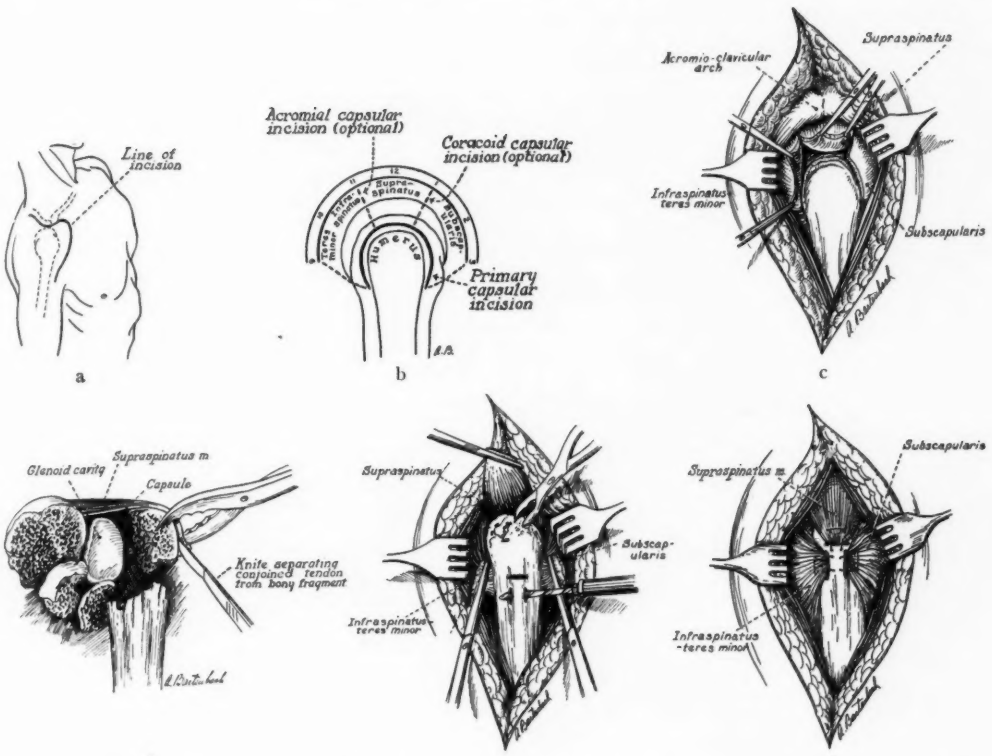

Fig. 10. a, Drawing showing the line of skin incision; b, diagram illustrating the "horseshoe" and "shoulder clock" as an aid to localization of the component capsular flaps; c, drawing representing the aid of a diagram in the preparation of flaps; d, the removal of bony fragments from the conjoined tendon; e, the rounding of the upper end of the shaft and preparation of three grooves, one horizontal and two vertical, prior to final transplantation of capsular components; f, final location of transplanted conjoined tendons. Note that the line of closure between the components, such as the supraspinatus and infraspinatus, reconstitutes capsule.

plete tear" of the supraspinatus. Study of the lateral aspect of the shoulder would show that any sizable laceration of the key-stone supraspinatus tendon would seriously affect the two components in front and back. Moreover, it would seem to be physically impossible for the supraspinatus alone to be a worthy antagonist for the deltoid which is six times larger and heavier.

Closer to the truth, yet still inadequate, was the statement made in 1933 (2), that the "short rotators" are in reality "suspensory muscles whose chief action it is to hold the head of the humerus firmly against the glenoid where the more powerful flexors and extensors can exert their full force on a firm base."

If this is not the whole truth, let us attempt to define our present concepts regarding the physiology of shoulder motion. *Movement of the shoulder demands both fixation of the glenoid and the head of the humerus, with effort increasing the demand. Two distinct muscle systems are involved in effecting this. Dysfunction of any muscle component will seriously disturb the fine muscle balance essential to normal shoulder movement.*

Finally, surgeons interested in the problems of bone and joint surgery will concur with the statement that occasionally resection of the head of the humerus is inevitable. Considering the operation as a surgical entity, they will agree that stabilization of such a

shoulder presents a difficult surgical problem. If such a shoulder can not only be stabilized, but reconstructed to effect functional return, then other more or less distantly related problems in shoulder surgery should be affected.

SUMMARY AND CONCLUSIONS

1. Resection of the head of the humerus is reported in two illustrative cases.

2. In these and other individuals the end-result has been stable shoulders but with considerable variation in function.

3. Investigations to determine the reason for this have considerably altered our ideas concerning the basic anatomy and physiology of the shoulder: (a) Normal shoulder movement demands both fixation of the glenoid and the head of the humerus; (b) there would seem to be a considerable difference in the muscle physiology of the shoulder joint in relaxed motion and when the same joint performs under the stimulus of effort; (c) the anatomical results can be summarized by saying that the "short rotators" are in reality capsular muscles, and that these are divided into three distinct component parts.

4. An operative procedure is described that in selected cases has been consistently effective. It has simplified surgical approach and when modified can meet varied surgical needs in civilian practice.

5. Reports from the first World War lead to the belief that in military surgery, a reconstructive operation of the type described would be of great service.

REFERENCES

1. Albee, F. H. Surg. Gyn. Obst., 1921, 32: 1–19.
2. Jones, Laurence. Ann. Surg., 1933, 97: 217–225.
3. Keibel-Mall. Human Embryology. Vol. 1, pp. 488–489. Philadelphia: J. B Lippincott & Co. 1910.
4. Nové-Josserand and Tuffier. Arch. méd. pharm. mil., 1916, 66: 145–166.
5. Watson-Jones, R. Brit. M. J., 1938, 2: 29.

THE SURGICAL EXPOSURE OF THE GALL BLADDER AND BILE DUCTS

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TO those who for many years have been operating upon patients with gall stones, a discussion of the surgical exposure of the gall bladder and bile ducts must seem almost presumptuous. I would not consider presenting the matter were it not for the fact that, in my opinion, there is a real need for improving the methods now in general use. The exposure obtained by the procedures which I developed some years ago has been so satisfactory in our clinic and has received such favorable comment from others visiting the clinic that I feel it timely to describe the steps used. I am convinced that this plan will often make possible better operative procedures not alone upon the bile ducts but as well upon the very important area at the junction of the cystic, common and hepatic ducts, and a wide area adjacent; in addition, and of great importance, the operation can be carried out under direct vision.

No one who has done very much biliary tract surgery will deny that the area most dangerous, most involved, and most likely to produce complications in biliary tract surgery, lies at the very bottom of what in the operative field may be described as a very deep hole. The very bottom of this deep hole is made up of the bile ducts; the often complicated and atypical anatomical relationships between the cystic duct, the common duct, the hepatic duct, and accessory ducts; the cystic artery; the hepatic artery; at times the portal vein; the duodenum; and the head of the pancreas. Excessive bleeding from tearing of the cystic or right branch of the hepatic artery in this deep hole, unless there is adequate exposure, creates an emergency which threatens life; inaccurate control of hemorrhage can and does cause injuries to the bile ducts which result in almost irreparable strictures.

From the Department of Surgery, The Lahey Clinic.

For 16 years I have preached and written concerning the need of making certain, when operating for gall stones, that not only the stones in the gall bladder are removed but that those within the bile ducts are also removed. This can be done by exploring the bile ducts; exploration will reveal the presence of stones in approximately half of the cases. The ability of a group of several surgeons in this clinic to open and explore the bile ducts and yet show an ever decreasing mortality rate, is, I believe, in a large measure due to their use of this method of exposing the operative field, an exposure which enables them to operate upon the ducts and adjacent structures through a wide anatomical exposure, in a dry field, with adequate light, and with the patient's abdominal muscles and contents relaxed and quiet.

I believe that any method of exposing the biliary tract region should be developed along sequential lines. The basic factor of such a method is, in my opinion and experience, a quiet, relaxed abdominal wall and contents. This can be obtained with proper spinal anesthesia, without which the plan of exposure here described becomes, if not impossible, at least very much less satisfactory.

To silence possible criticism of the plan, since its most completely satisfactory employment requires spinal anesthesia, I would like to say that for several years in this clinic all abdominal operations have been done under spinal anesthesia—gas anesthesia or intravenous pentothal anesthesia being used when desired to protect the patient from the psychic burden of being awake while the operation progresses. The spinal anesthesia has always been given by a full time, trained physician anesthetist from the department of anesthesia in the clinic. As evidence of the safety of the method there have been no deaths from this type of anesthesia for years

and there has been to date not a single neurological complication. It seems obvious to me, therefore, from an experience of approximately 15,000 cases, that, in the hands of those trained so as to be expert in its administration and maintenance, spinal anesthesia has been proved to be a safe and most satisfactory type of anesthesia. In the hands of those not trained and experienced as experts in this type of anesthesia, I would be the first to admit its hazards; the employment of spinal anesthesia by those unqualified in its use by training or experience has brought about untoward criticism and has created unjustified prejudices against it. As in so many parallel situations in scientific practice, just as it provides such beautifully quiet and relaxed anatomical fields for delicate, accurate, and meticulous dissections, so it also demands care, patience, and experience, not only, and most important, in its administration but also in meeting the emergencies which sometimes arise during its administration. Such emergencies can be successfully dealt with by those expert and experienced in its management.[1]

The number of reports of attempts to make the main bile ducts more visible and so more easily approached is evidence that surgeons realize that adequate exposure of the operative field in biliary tract surgery is essential if such operations are to be conducted safely. The attempts to improve the exposure of the ducts have been largely concerned with placing objects under the patient's back at the level of the gall bladder and bile ducts. At first sand bags were used, then mechanical back elevators with the patient in the reversed Trendelenburg position were employed, the idea being to remove from the field of gravity the adjacent anatomical structures. Early in our experience we adapted for the purpose a section of balloon tire inner tube. The section chosen included the valve for inflation. Pieces of rubber were vulcanized over the cut ends of the tube. The section of tube, uninflated, was placed beneath the patient's back. It was connected with an air bottle or gas tank and later inflated when the patient's abdomen was opened and the gall bladder exposed. All of these procedures were based upon fallacious reasoning that thus removing the adjacent anatomical structures from the field would make the ducts more accessible. The methods were not productive of very much improvement in the exposure of the ducts and the cystic and common duct junction. The fact that the common and hepatic ducts, together with the cystic junction and associated areas are lax structures makes difficult the exposure of the area; hence it is difficult to bring the structures close to the abdominal wall where they can be dealt with more safely. The structure into which the ducts enter—the duodenum—because of its mobility, tends to move to the right toward the point of origin of the ducts and is fixed in the fissure of the liver and so permits the ducts to sink back into the very bottom of the operative field, which has been called the pouch of Morison. Nothing placed under the back will overcome the laxity of the duct or sufficiently elevate the posterior abdominal wall so that the lax ducts will be made more visible and brought nearer to the surface so they can be more safely dealt with.

It was realized that only by mobilizing to the left the structure into which the duct was inserted and keeping its origin in the fissure of the liver fixed, could the duct be straightened out, put on the stretch, and thus brought up out of its deep position and made clearly visible and closer to the abdominal wall.

The length of the incision is also an important factor in the exposure. Comparison of what one gains or hazards with incisions of adequate or inadequate length reveals a great deal. With any incision that limits ease and adequacy of exposure of the deep anatomical structures of and about the bile ducts, one exchanges the saving of 3 or 4 inches of the incision in the abdominal wall for whatever the additional risks are to the deep anatomical structures, and because of this the patient's future.

THE TECHNIQUE

Spinal anesthesia is used and an incision of ample length is made. The abdomen is thus

[1]Some years ago there was established at the Lahey Clinic a school to train anesthetists, which provided 2 full time years of sound training in the subject. From this school 4 anesthetists trained in all branches of anesthesia have been placed yearly in positions in different sections of the country. Similar training is being given by other groups and by individual anesthetists throughout the country, so that increasing numbers of men capable of safely administering spinal and every type of anesthesia are being made available.

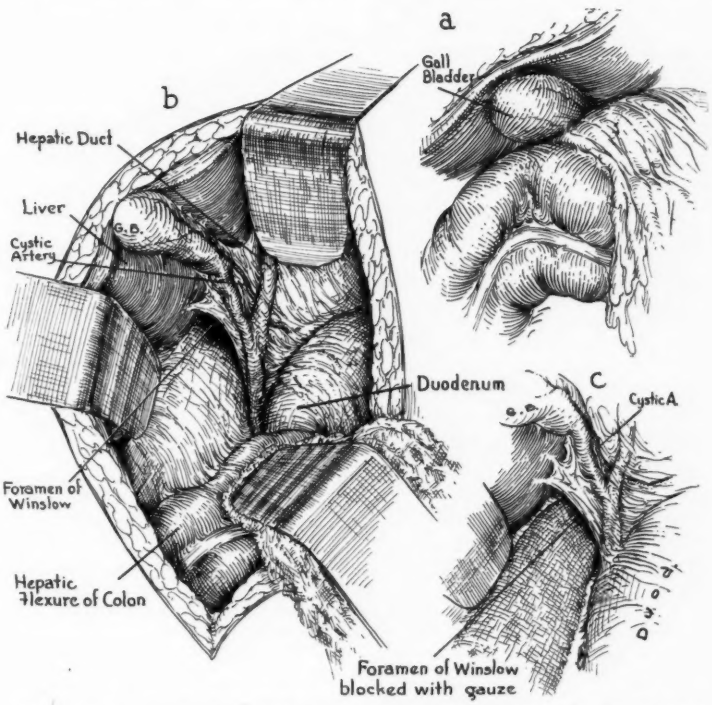

Fig. 1. a, The anatomical relations of the gall bladder and hepatic flexure when the abdomen is first opened. b, The hepatic flexure and duodenum mobilized to the left and held in this position with retractors upon gauze pads. The clamp on the gall bladder is not shown, but by traction and mobilization of the duodenum and hepatic flexure to the left this exposure of the ducts and foramen of Winslow is obtained. Note also the visualization of the cystic artery with the peritoneum over the duct opening. c, The foramen of Winslow blocked with gauze.

opened and the gall bladder is exposed and grasped with a right angle clamp or any other type one prefers. The gall bladder is pulled upward and outward and the duodenum is pulled to the left so that any bands between the duodenum and the gall bladder are put on the stretch and severed. The hepatic flexure, which is often fixed by bands to the under surface of the liver, is freed so that the flexure can be completely dislocated to the left. The field is then ready for exposure. A long, folded, wet pad is placed over the outer edge of the duodenum up to the pylorus and with a Deaver type of retractor placed over it retraction is made to the left. The hepatic flexure and ascending colon are pushed over to the left and another gauze pad is placed along their external edges (Fig. 1, *b*). A Deaver type of retractor is placed over this area and the flexure and ascending colon are pulled to the left. This procedure, the retractor pulling the wound edges apart, completely exposes the pouch of Morison. The common and hepatic ducts are put on the stretch as these two structures—the duodenum and hepatic flexure with the retrocolic duodenum behind it—are pulled to the left so that the ducts are made completely visible. If another clamp is now placed upon the ampulla of the gall bladder and the gall bladder is further elevated, traction on the cystic duct will not only demonstrate the duct and its entrance into the common duct plainly but will so open the foramen of Winslow that it, with its posterior boundary made by the vena cava, will be plainly visible (Fig. 1, *b*).

With an exposure such as this, a gauze strip can be passed into the foramen of Winslow to block it (Fig. 1, *c*). The remainder of the strip may be so laid into the fossa of Morison that, as one will quickly see when this exposure is obtained, should a considerable amount of infected bile escape in opening the ducts or should a pool of blood accumulate at the very apex of the deepest point of the operative field represented by the foramen of Winslow, material thus released will not pass into the lesser peritoneal cavity or pool, at this point to produce a subhepatic or subphrenic postoperative abscess. For several years I have advocated among our group of surgeons the value of plugging the foramen of Winslow and packing the fossa of Morison, and I am sure this precaution has rewarded us in better results, in that catching the spilled bile and stones has prevented complications.

With this exposure, flaps of peritoneum can be safely cut from the gall bladder with which to cover its bed after its removal. The course and position of the hepatic artery and the course and relation of the cystic artery to the cystic duct can be readily demonstrated and visualized (Fig. 1, *b* and *c*). Accurate dissection of the cystic duct down to the point of entrance into the common duct can be accomplished. Not infrequently the discharge of bile from torn, small accessory ducts occurring at this point can be demonstrated, the open end of the accessory duct picked up and tied, and the postoperative escape of bile into the wound from the open end of the accessory duct prevented. As the result of having again and again demonstrated, after removal of the gall bladder, torn accessory bile ducts either at the junction of the cystic and the common and hepatic ducts, or in the bed of the liver, I am sure that when there is an escape of bile after cholecystectomy it is in most cases from tears not discovered and therefore not ligated in the accessory bile ducts. That the escape of bile particularly from an accessory bile duct in the bed of the liver can result in the escape of a serious amount of bile into the peritoneal cavity is borne out by one case I have encountered. In this instance a torn duct in the liver bed leaked at least a dram of bile per minute and undoubtedly within a few days would have completely filled the abdomen with bile. While it is true that bile peritonitis can frequently be recognized and controlled it is a complication to be prevented and can be avoided if proper precautions are taken.

By this exposure the cystic artery, as we have frequently demonstrated, can always be found first, carefully dissected, cut, and clamped, and then the dissection between the cystic, common, and hepatic ducts can be made very accurately. I believe nothing has played a greater part in lowering our mortality rates or has given us the confidence to explore the common ducts in such a high percentage of cases as has this plan of exposure. After its use for a number of years we can say without hesitation that the traction made upon the duodenum and the hepatic flexure by retractors on the top of gauze in no way increases the postoperative distention or complicates the postoperative recovery.

SURGICAL REPAIR OF RECENT LID LACERATIONS

Intramarginal Splinting Suture

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LACERATIONS of the eyelids, while not uncommon in civil practice, are seen very frequently as part of war injuries. The ophthalmologist knows the importance of immediate precise repair, but others who see these cases first are less likely to be aware of this necessity.

When injuries involving the margin of the lid are not perfectly repaired, faulty healing due to the change in the action of the strong band of orbicularis muscle fibers near the cilia causes cosmetic defects and functional disturbances.

This disturbed physiology was markedly demonstrated in 1 of the 25 cases that form the basis for this communication. During a brawl, a man had his right upper lid torn 5 millimeters from the punctum by a laceration which extended 7 millimeters upward and then ran parallel to the margin up to the external lateral ligament. When the patient closed his eyes forcibly, the tip of the flap rose away from the eyeball and stood erect. When he opened his eyes, the orbicularis became relaxed and the flap came to rest flat against the eyeball. At the time of injury, a reflex spasm of the orbicularis takes place which accounts for the displacement of the tongue toward one canthus or the other. The almost constant bevelling of the wound is thus also explained. Once the margin is torn, the action of the orbicularis is changed to a lateral traction which tends to separate the lips of the wound and ultimately to cause a notch.

The methods of repairing lid lacerations deal mainly with three problems: (1) the perfect apposition of the margins of the lid border to prevent the formation of a notch; (2) increasing the raw area in the substance of the lid itself to create a broader adhesion; (3) the overcorrection of an avulsed lid to insure its approximation and to restore its level.

Literature

The procedures used prior to the World War in the repair of fresh lacerations of the lid margin are merely suggested in the literature dealing with ectropion, tumors, congenital colobomas, and the post-traumatic notch. Duverger (2) in 1916, described the removal of a triangle of skin and orbicularis from one side of the wound, and a similar equal triangle of tarsus and conjunctiva from the other, thus permitting the tissue to overlap to produce a "Z" shaped base of adhesions when the lid was finally repaired. Attention was focused on placing the deep sutures off to one side of, and not directly behind, the superficial skin sutures. It is interesting in this connection to note that when Sheehan, 10 years later, pictured Duverger's operation, he added two tiny intramarginal sutures, which he termed "the most important suture."

In 1920, Wheeler (16) published a description of his "Halving Operation" in which he perfected Duverger's overlapping technique. In one patient in whom the globe had been previously lost, he "sewed the lids together so that the lower margin would act as a splint for the upper." To Wheeler then, belongs the credit of splinting one lid margin against the other. He laid particular stress on the importance of a flamed-adhesive pressure dressing reinforced with a supporting bandage. This pressure dressing insures primary union by immobilizing the tissues, and prevents infection or at least minimizes it by forcing the exuded serum into the dressing.

Still later, Peter, 1932, suggested the suturing together of both lids when the injury was extensive, and even recommended intramarginal tarsorrhaphy.

Classification

Recent lid lacerations may be classified as follows:

A. Extramarginal, not involving the lid border. They may be (1) superficial or (2) deep.

From the Ophthalmological Service of Harlem Hospital. Presented before New York Academy of Medicine, Section of Ophthalmology, February 19, 1940.

B. Intramarginal. Intramarginal lacerations may be (1) canalicular (avulsion) or (2) extracanalicular. Extracanalicular lesions may affect (a) one lid and be either single or multiple or (b) they may affect both lids and consist of (1) one tear in the margin of one lid at a point distant from the tear in the other or have (2) both tears in a line and continue through the margin of both lids.

Treatment

The general principles of treatment universally accepted have been repeatedly stressed in the literature by various authors. They may be summarized briefly as follows:

Prompt repair gives the best results because it avoids later deformities. Simple suturing of the edges of a defect is adequate if less than one-third the length of the lid is missing. Proper cleansing is mandatory. Débridement should be minimal though definitely necrotic tissue must be excised.

Bruised and ecchymotic tags of tissue may be saved.

The use of an intramarginal suture is essential.

Closing of conjunctiva to prevent adhesions to the globe is required.

Suturing of levator and tarso-orbital fascia is necessary to avoid ptosis.

Repairing the orbicularis should not be neglected.

A special suture near the cilia should be made to catch the muscle of Riolan to prevent the formation of a notch.

Precise suturing of skin restores the continuity of the lid.

Both eyes should be bandaged to maintain immobilization of the sutured lid.

Wiener suggested trimming the lips to an elliptical defect so as to avoid a notch.

Anesthesia. In the great majority of cases, instillation in the conjunctiva of 4 per cent cocaine and adrenalin, and a tampon of 1 per cent pontocaine in the lower sac plus the infiltration of the lids with 2 per cent or 4 per cent novocain render the repair painless. Only when the patient is nonco-operative is general anesthesia indicated.

Dressing and after-care. The moderately severe compression dressing is not disturbed for 5 days. Then, all superficial sutures are removed while the patient is asked to keep both eyes shut. A light dressing is applied. On the following day the eye is left open but the wound is kept covered with 2 per cent boric acid ointment for a week.

Extramarginal Lacerations

Superficial wounds of the skin require simple cleansing and coaptation either by interrupted sutures or by butterfly adhesive strips. A light dressing is sufficient.

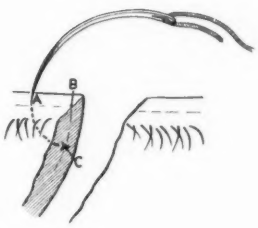
Deep lacerations require thorough cleansing with soap and water, alcohol and ether, and painting with iodine. The conjunctiva and the expansion of the levator aponeurosis are together closed with interrupted silk sutures. Then the skin and orbicularis are similarly treated. A moderately heavy pressure dressing usually eliminates the necessity for drainage of the wound, even when contaminated, and almost always insures primary healing.

Specially Devised Single Intramarginal Splinting Suture

When only one lid margin is lacerated, a strong double armed suture is passed through the tips of the wound by equal quadrant arcs in the plane of the gray line. As the lid is drawn away from the eyeball by this suture, the previously adjacent edges of the lacerated conjunctiva, levator expansion, and tarsus are approximated so that they may be repaired by buried interrupted catgut sutures. When the arms of this intramarginal suture are then brought through the gray line of the intact margin of the other lid to emerge from the skin beyond the cilia, the ends are tied over a rubber bolster. In this way a splinting mechanism of the torn border is created. Since the lines of traction are all in the plane common to the gray line of each lid, any anteroposterior displacement is avoided; and since the intact border of one lid flattens the torn margin of the other, no vertical displacement can take place. The varying degree of bevelling of the wound usually present serves to increase the surface for adhesion.

Detailed Steps in the Technique

A. Intramarginal suture placed. A No. 1 braided silk double armed suture is used. The temporal flap is grasped with fixation forceps, nearly parallel to the border. The point of one needle is placed on the gray line 3 millimeters from the torn edge. It is passed in the plane of the gray line to appear in the raw surface, 3 millimeters from the border (Fig. 1). The



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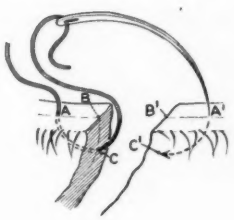

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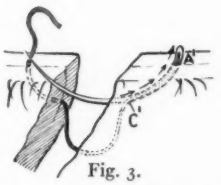

Fig. 3.

Fig. 4.

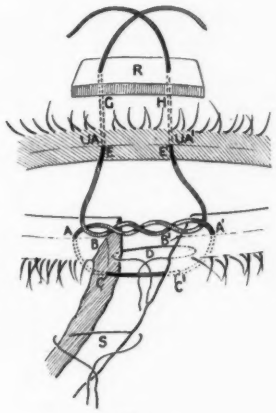

Fig. 5.

Fig. 1. First step of intramarginal suture. The lacerated lower right lid is schematically represented. The faint horizontal lines suggest the gray line where the needle is poised at *A* and the broken arrows indicate the path of the needle point through the thickness of the lid in the plane of the gray line *AC*. The lowermost small arrow at *C* is the site of exit in the torn surface. $AB=BC$

Fig. 2. Second step of intramarginal suture: *tract made in other lip*. The temporal arc of the suture has been drawn through and the tract $A'C'$ in the nasal lip is begun. $A'B=B'C'$ and $AC=A'C'$. Needle is not drawn through.

Fig. 3. Third step of intramarginal suture. After the tract $A'C'$ is made, the needle is withdrawn and grasped by the needle-holder nearer the point and the eye of the needle entered in the hidden raw surface at C' to emerge at A'.

Fig. 4. Crossing of the suture on the gray line to check alinement of the flaps. The arrows indicate the direction that the arms of the suture are drawn so as to approximate the torn flaps. If vertical or horizontal displacement is present, the arcs AC and $A'C'$ in Figure 3 are unequal and the second (nasal) tract must be reformed.

Fig. 5. The intramarginal suture completed. *D* represents one of the conjunctival sutures, whose loops are on the conjunctival surface and whose knots are to become buried between the raw surfaces when the skin is repaired. The first half of a surgeon's knot $(A-A')$ has been formed, but not pulled taut. The nasal arm of the suture emerging from A' now lies over *A* and has been made to enter the gray line of the upper lid at *E*. $EE'=AB+A'B'$ and travels in the plane of the gray line *EG* to emerge from the skin at *G* 4 millimeters above the border. The other arm follows a similar path. *R* shows the rubber bolster over which the suture is tied after the slack has been taken up. *S* indicates one of the interrupted skin sutures.

nasal flap is then grasped and the suture is entered in the torn edge 3 millimeters from the tip in such a way that it travels in the plane of the gray line where it appears exactly 3 millimeters from the tip of the nasal flap.

To make certain that the second arc is in the plane of the gray line the following variation in the technique is used:

The fixation forceps are released, applied to the nasal flap 5 millimeters from its torn edge. The same needle used in making the temporal arc in the tip is placed on the gray line 3 millimeters from the nasal torn edge and made to produce a tract in the plane of the gray line which emerges in the raw wound 3 millimeters below the border (Fig. 2). Without releasing the needle from the holder, the surgeon withdraws it and re-enters the tract at the previous point of exit of the needle. Its point is made to emerge from the gray line where it was first punctured. Another variation may be used by letting the threaded eye of the needle enter the tract at its opening in the wound and retrace its path much as a small curved probe would do (Fig. 3). The needle holder now grasps the needle near the eye, pulls it through the tract, thus drawing the suture and completing the first loop of the intramarginal suture.

B. Alinement checked. To insure the exact alinement of the two flaps, the arms of the suture are crossed without being tied so as to lie on the gray line of the lid border (Fig. 4). If there is any displacement, vertical or forward, it must be assumed that one part of the loop is outside the plane of the gray line. The corresponding arm of the suture must be withdrawn and repassed accurately.

C. Conjunctiva-tarsus repaired. The lid is everted by drawing it away from the eyeball by means of the still untied intramarginal suture. Because of the traction by this loop, the margins of the conjunctival wound fall in line so that previously corresponding parts are now adjacent and easily recognized. After the wound is permitted to spread a bit, inter-

rupted No. 000 plain catgut atraumatic sutures, starting at the angle of the tear and approaching the border, are passed so that the loops (Fig. 5, *D*) are on the conjunctival side, and the knots are tied so as to be buried between the raw edges when the skin is ultimately repaired. Catgut is used to make unnecessary the later removal of deep sutures, thus avoiding the risk of stretching the lid and of weakening the adhesions. If the repair of the conjunctiva is omitted, the fornix in the region of the tear may be obliterated by scar tissue when healing is complete.

D. Splinting procedure. To obtain smooth union of the lacerated lid margin, it must be splinted against the opposite intact one by tying the first half of a surgeon's knot which draws both tips of the laceration together.

Two turns are made in the first half of the surgeon's knot. The second part of the tie is here omitted. When drawn snug, with the arms of the suture held vertically, the half-tie prevents slipping of the knot and thus holds the wound closed. At this point the upper lid is grasped by fixation forceps at a point corresponding to the tear in the lower border, and the needle (the only one that has been used up to now) coming from the nasal flap of the lower lid, but now lying crossed on the lid margin to ride over the temporal lip of the wound, enters the plane of the gray line of the upper lid perpendicularly, just temporal to the fixation forceps to emerge in the skin 4 millimeters above the cilia (Fig. 5). The other needle enters just nasal to the fixation forceps in a similar manner. An interval of 6 millimeters separates the two arms.

The sutures (now crossed) are passed in the plane of the gray line of the other intact lid to appear in the skin 4 millimeters above the cilia where they are tied over a rubber bolster.

A rubber bolster previously cut from a catheter tube is held in an artery clamp at right angles to the tube's long axis, and the needles are passed from the concave surface of the catheter through it, close to the artery clamp. This bolster is now pushed along the arms of the suture down to the skin, and the artery clamp released. The slack of the suture is taken up and the first part of a square knot made on the bolster. This taking up of the slack is repeated until the lips of the wound are just snug enough to be sure that the sutures shall not cut through later when the tissues become edematous. Finally, the square knot is completed.

E. Repair of skin and orbicularis. Interrupted No. 1 twisted paraffined black silk sutures, starting from the angle of the wound and approaching the lid margin, close the skin and orbicularis. It is most important to make sure that a separate stitch is taken to include the strip of orbicularis near the lashes, called Riolan's muscle.

F. Dressing. A thin layer of sterile vaseline is applied to the lids and an adequate amount of gauze fluffs is pressed down with *moderately severe pressure* by stretched, flamed adhesive strips as Wheeler recommended in his grafting operations on the lids. Five days later all silk sutures are removed, the patient having first been cautioned to keep both eyes closed without squeezing while this is being done. In 7 days the eyes are left open. The wound is kept covered with 2 per cent boric ointment for an additional 2 weeks.

DOUBLE INTRAMARGINAL SPLINTING SUTURE

If both lids are injured by lacerations at different points on the borders, two double armed intramarginal splinting sutures are necessary. Each is placed as here described, then is half tied after the conjunctival repair and finally brought through the opposing intact portion of the other lid and carried through a rubber bolster. Only after both bolsters are in place is the first suture tied; otherwise it would be difficult to insure accurate approximation of the second splinting suture. At the end of this procedure, the torn lower margin will be held firmly against the intact upper, and vice versa.

"FIGURE-OF-EIGHT" SPLINTING SUTURE (FIG. 6)

When the lacerations of both lids meet at a point so that there is no opposing intact portion of lid to be used as a splint, the four lips of the borders are brought together by one double armed suture in the plane of the gray lines passed so as to form a figure-of-eight. When tied over a bolster, the four tips meet in a point splinting one against the other, and the suture restores the continuity of the margins of the lids.

The technique may be outlined as follows (Fig. 6):

A. Lower intramarginal suture is placed as above (1) temporal arc, *A C;* (2) nasal tract, *A′C′;* (3) the nasal arc threaded; and (4) alinement is checked.

B. The suture is crossed on the lid margin, AE' and $A'E$, but no part of a knot is made. The loop in the lower lid now forms the lower half, $XACC'A'$ of the "figure-of-eight."

C. Lower conjunctiva repaired.

D. The upper intramarginal loop. Temporary intramarginal suture placed in the lid and then removed to make place for the loop after upper conjunctiva has been repaired.

1. Temporal arc, EO, is entered by the needle which comes from A' the nasal lip of the lower lid margin, emerging from the raw surface of the temporal side of the upper laceration 3 millimeters above the border, O.

2. Nasal arc, EO' is entered by the needle which comes from A the temporal lip of the lower lid margin emerging from the raw surface of the nasal side of upper laceration 3 millimeters above border, O'.

3. At this stage the suture lies in the depth of the wound, the arms crossing a second time forming in the upper lid the top of the figure-of-eight, $XEOO'E'$. Each suture is now continued in the plane of the gray line, into the opposite edge, D and D', 2 millimeters above O and O' and emerges from the skin 3 millimeters from the torn edge, S and S'.

E. The suture tied over a rubber bolster, after the slack is taken up, splints the four tips against each other.

F. Skin and orbicularis repaired by interrupted silk sutures.

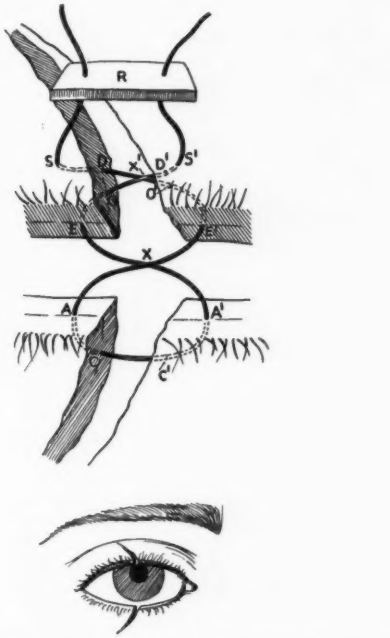

Fig. 6. The figure-of-eight suture. When both lids are lacerated at a common point. The arcs AC, $A'C'$, and EO, $E'O'$ are all equal. A, A', E, and E' are on the gray line, and equal distance from the tip. C, C', O, and O', are on the raw edge in the plane of the gray line a similar distance from the tip. D, and D' are on the raw surface in the plane of the gray line and $DO=D'O'$. The first crossing X lies between the lid margins in the plane of the gray lines. The second crossing X' is in the plane of the gray line between the raw edges of the upper wound. The sutures emerge 3 millimeters from the edge at S and at S' and are finally brought through the rubber bolster R. On taking up the slack of the suture all four tips of the lacerations are accurately approximated and splinted one against another.

AVULSION OF THE LOWER LID (FIGS. 7 to 9)

In any consideration of the repair of avulsion of the lower lid, Wheeler's ideas contribute the major portion of the discussion. He (17) first showed how there is "a strong tendency for the flap that has been torn loose to heal in a position too low and not close enough to the eyeball so that an ectropion results, with inability to close the lids properly. In adjusting such a wound it is important that the angle of the flap be carried upward and backward to a point of overcorrection. To accomplish this, after suturing the conjunctiva with fine silk sutures, introduce heavier silk sutures (No. 5) through the skin in a diagonal direction; and apply a gauze dressing with pressure bandage."

The following excerpts from Wheeler's *Collected Papers* are of interest:

"Proper anchorage of the angle of the lid flaps backward and upward in a position of slight overcorrection is important. This can be accomplished by carrying the skin sutures through more deeply in the tissues on the nasal side than in the lid flap, and by anchoring the apex back to the canthal ligament, carry the angle of the flap as high as possible." (p. 113.)

"The margin of the lid flap is apt to be too narrow. It is important that the opposing raw surfaces should match. A simple and effective scheme is to split the lid flap at its edge and then increase its healing surface so that it will cover the opposing healing surface. The conjunctiva should be carefully sutured before the skin sutures are placed in the end of the flap." (p. 114.)

"Some little nasal flap of skin can be seen and the tarsal flap slipped up and behind the little skin flap and held there by a mattress suture, tied so as to assure apposition of the raw surface, but not too tightly. Then the end of the tarsus was anchored upward and backward securely by a suture which passed through the canthal ligament. It is safe to tie such a suture snugly. In the healing process there was no slipping of the flaps. One can afford to

sacrifice healthy skin of the lid when it seems very scarce, in order to get such a flap of tarsus to help in the halving process. I think too much stress cannot be given to this idea." (p. 116.) (Wheeler, John M., *Collected Papers.*)

Later, to repair a badly healed avulsion he divided the temporal flap of the avulsed lid into two layers, the first consisting of skin and orbicularis, the second of tarsus and conjunctiva. The second layer he anchored by a mattress suture to the raw tissue, which lies posteriorly and above the inner canthal ligament. In this procedure one canaliculus was necessarily sacrificed, the other being deemed sufficient for drainage of the tears into the nose. To quote from Wheeler:

"Traumatic coloboma of lower eyelid near inner canthus: 'Improper primary healing of such a wound results in a coloboma near the inner canthus and ectropion of the lid near the coloboma. Sutures are placed diagonally along the incision in such a way as to advance the whole flap and have as little pull as possible for the sutures at the apex during the healing process. Of greater importance is the adjustment of the tissues at the apex of the flap. The small amount of skin just external to the inner canthus is carefully and completely undermined. The skin and orbicularis are stripped from the anterior surface of the tarsus so as to expose 4 or 5 millimeters of the tarsus. A suture is carried through the exposed tarsus, and then it is carried well into it so as to get a firm hold. A mattress suture mounted with two needles is carried through the exposed tarsus, then through the flap of skin which has been dissected up near the upper canthus. When the sutures are snugly tied the apposition will be secure and the lid will lie well back against the globe and well up to the proper level, or even high enough to be in a position of overcorrection. Without this careful adjustment and definite overlapping of raw surfaces one cannot be sure of complete obliteration of the deformity.'" (p. 185.)

Savin in 1940, discussing "Eye Injuries in Warfare," outlined the following pertinent general observations and made special reference to preserving the lumen of the canaliculus in avulsion of the lower lid:

Blood supply of lids is exceptionally good. Extensive wound excisions, such as general surgeons tend to perform, are not necessary. Sloughing is rare. Proper alinement is essential. Lashes must not be allowed to turn in.

Avulsion: Fine silk suture is passed through the canaliculus lumen—and is entered into the medial cut end of the canaliculus, passed a little way along its lumen and then turned forward so that the point is brought out on the skin of the face. Sutures tightened. Apposition and union readily result.

I have modified Wheeler's technique by anchoring the unsplit flap by a deep double armed suture which takes bites in the periosteum above the lacrimal sac. This is done with a Deschamp needle shaped like a button-hook. The temporal portion of the torn canaliculus is threaded by a heavy silk or catgut suture which is carried through the opening in the nasal remnant of the canaliculus into the lacrimal sac and brought out through the skin over it. There it is tied into a loop or loose ring to prevent its slipping. The suture will follow the distortion of the canaliculus caused by the deep sutures and avoid overriding of one part of the canaliculus on the other. The wound heals by first intention, and the approximated openings of the ends of the canaliculus have an excellent chance of healing without scar tissue interrupting the continuity of the lumen. The skin and orbicularis are sutured so that the bite in the nasal lip is 2 or 3 millimeters higher than that in the temporal one. A more detailed description of the deep suture technique follows:

Deep suture (*Fig. 7*).

1. A double armed No. 2 braided black silk suture is passed from the conjunctival side into the raw edge just below the canalicular border, a 3 millimeter loop, *D*, on the conjunctiva separating the arms of the suture.

2. The needles are removed from the suture which is threaded successively on a Yankauer needle or a modified Deschamp, shaped like a button-hook. The suture is passed through the eye from the convex side of the hook.

3. The tip of the Deschamp is insinuated in the raw tissue from which the lid was torn, between the periosteum and overlying tissues and carried to a point near the dome of the lacrimal sac, where the periosteum, *S*, is picked up by the needle point until its point is felt through the skin, *S'*. The needle, having transfixed the periosteum for about 2 millimeters, is rotated by lowering of the handle.

4. A strong pair of forceps straddles the hidden needle point and impales the skin on it by lowering the handle a bit more. After the eye of the needle appears, the suture on its convex side is released from the eye by forceps, and grasped by an artery clamp as the button-hook Deschamp is rotated out of the wound.

5. The second arm, *P P'*, of the suture is threaded in a similar fashion coming out through the skin 1 millimeter below the first.

Canaliculus threaded (*Fig. 8.*)

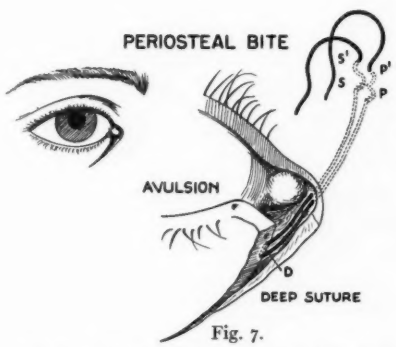

Fig. 7.

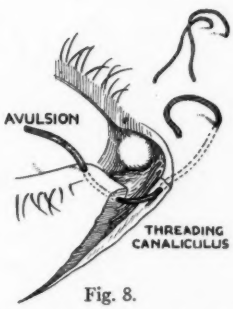

Fig. 8.

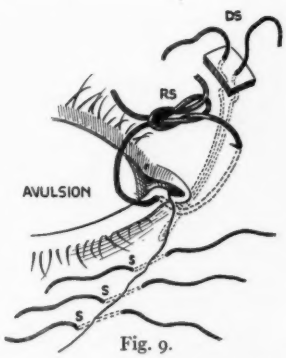

Fig. 9.

Fig. 7. *Avulsion.* Mattress suture (No. 2 braided) inserted at *D* in posterior part of tip of tongue below the canaliculus. Needles are removed and one arm of suture is threaded on a Yankauer nasal septum needle, or button-hook, Deschamp, and introduced below the caruncle at its nasal extremity. *S* represents the bite in the periosteum as high as one can get and *S'* the point of emergence from the skin. The other arm of the suture similarly follows the first at *P* and at *P'*. The suture is not tied until canaliculus has been threaded.

Fig. 8. Canaliculus threaded. A needle threaded with heavy chromic catgut suture has entered the canaliculus at the punctum. The nasal orifice of the canaliculus, having been dilated, permits the suture to enter the sac itself. The suture emerges from the skin over it.

Fig. 9. Repair of avulsion. The suture threading the canaliculus is tied so loose that a ring of catgut results. The deep suture has had its slack taken up and is to be tied over a bolster so that the lower lid lies higher and posterior to its normal position. *D.S.*, Deep suture; *R.S.*, ring suture; *S*, skin closure sutures placed so that temporal bite is taken lower than the nasal.

1. The punctum is dilated moderately with a conical dilator and the canaliculus with a No. 4 probe.

2. A heavy silk or chromic suture enters the punctum to emerge in the temporal raw edge of the canaliculus and continues on into the nasal stump where its orifice may have to be dilated after identification.

3. To prove communication with the lacrimal sac, a probe may be used or the sac irrigated with fluorescin through the upper punctum.

4. The needle enters the sac to emerge in the skin above the internal canthal ligament. The suture may be left loose but to avoid slipping it is better to tie it into a loose ring 2 centimeters in diameter. Proper approximation is accomplished by the deep suture, which, after the slack has been taken up, is tied snugly but not tightly over a rubber or gauze bolster.

REPAIR OF NOTCH OR CONGENITAL COLOBOMA IN LID MARGIN

A small notch or congenital coloboma may be converted into a laceration of the lid by incising the lid border just where the notch begins and continuing the incision into the lid substance so as to excise an isosceles triangle with the notch as its base. The edges of the wound are made bevelled so as to increase the area for adhesion. After intramarginal splinting suture is placed, conjunctiva and tarsus are repaired and skin and orbicularis closed. When the notch is caused by the scar resulting from a badly approximated laceration, the scar is excised and the lid repaired as if freshly lacerated.

CONCLUSIONS

1. The vast majority of lacerations repaired in the manner here described healed so well that it was afterward difficult to determine the site of the injury. Two showed some notching due to poor healing because the patient tore off the dressings when coming out of the general anesthesia.

2. Immediate repair is indicated when there is no loss of tissue even though the wound is obviously contaminated.

3. Unless actually necrotic, no tissue need be excised, however bruised or ecchymotic. It is desirable not to straighten the edges of the laceration disregarding all irregularity, unless loss of substance interferes with proper approximation. The usual bevel of the edges should be preserved to broaden the base of adhesion. If there is to be a revision of the wound, the bevelling should be exaggerated rather than eliminated. Wiener's suggestion of making the edges of the wound concave rather than straight is an excellent one.

4. Unless the eyeball has been perforated, strong pressure is indicated to help avoid infection.

5. The repair of recent lid lacerations is achieved by a simplified procedure depending upon a suture (inserted in the plane of the gray lines of both lids) which splints one lid margin against the other, prevents vertical overriding, and avoids the development of a notch. Anteroposterior displacement is eliminated even when the eyeball is perforated or absent. Suturing of tarsus, tarso-orbital fascia, orbicularis, and skin prevents lateral spreading.

6. When both lids are lacerated at a common point a figure-of-eight intramarginal suture is indicated.

7. In avulsion of the lid, the overcorrection is aided by a suture anchored to the periosteum above the dome of the sac by a "buttonhook" Deschamp needle. The torn canaliculus should be threaded by a heavy suture in an attempt to preserve the lumen.

8. A small notch or congenital coloboma can be converted into a fresh, markedly bevelled laceration and repaired simply by the intramarginal splinting technique.

REFERENCES

1. Blaskovics, L., von, and Kreiker, A. Eingriffe Am Auge. P. 46. Stuttgart: Ferdinand Enke, 1938.
2. Duverger, C. Arch. opht., Par., 1916, 35: 667.
3. Duverger, C., and Velter, E. Ophtalmologie de guerre. P. 164. Paris: A. Maloine et Fils, 1919.
4. Finnoff, William C. Colorado M., 1933, 30: 7.
5. Foman, Samuel. Surgery of Injury and Plastic Repair. P. 836. Baltimore: The Williams & Wilkins Co., 1939.
6. Grant, Hendrie W. Minnesota M., 1932, 15: 771.
7. Imrie, Josef. Lidplastik und plastische Operationen anderer Weichteile des Gesichts. Pp. 68–72. Budapest: "Studium," 1928.
8. Johnson, A. B. Operative Therapeusis. Vol. 3, pp. 17–90. New York: Appleton & Co., 1915.
9. Lowther, A. H. J. Malaya Branch Brit. M. Ass., 1939, 3: 326.
10. Meller, Josef. Augenärztliche Eingriffe. 3d ed., p. 62. Vienna: Julius Springer, 1931.
11. Minsky, H. Arch. Ophth., 1940, 23: 1344.
12. Peter, Luther C. Pennsylvania M. J., 1932, 36: 566.
13. Savin, L. H. Med. Press & Circ., Lond., 1940, 204: 298–300.
14. Sheehan, Eastman. Plastic Surgery of the Orbit. Pp. 187, 206. New York: The Macmillan Co., 1927.
15. Spaeth, Edmund B. Principles and Practice of Ophthalmic Surgery. P. 257. Philadelphia: Lea & Febiger, 1939.
16. Wheeler, John M. Tr. Am. Ophth. Soc., 1919, 17: 263–271.
17. Idem. Johnson, A. B. Loc. cit., p. 66.
18. Idem. Internat. Ophth. Congr., 1922, pp. 443, 460.
19. Wiener, M., and Alvis, B. Y. Surgery of the Eye. Pp. 244, 282–289. Philadelphia and London: W. B. Saunders Co., 1939.

THE SURGICAL TREATMENT OF BILATERAL BRONCHIECTASIS

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THE feasibility of lobectomy for bronchiectasis is now well established in instances of unilobar, bilobar, and even universal bronchiectasis of one lung. Reports from various thoracic clinics throughout the world and our personal experience justify the conclusion that operative mortality in suitable risk patients submitted to unilateral partial pulmonary resection should not exceed 10 per cent and usually approaches 5 per cent. Total pneumonectomy is more hazardous, of course, but the complete removal of one lung for bronchiectasis is not accompanied by an excessive mortality. This is particularly true if the operation is performed on young subjects. We have undertaken total pneumonectomy for bronchiectasis in 4 children under 8 years of age. All recovered. After childhood the risk of pulmonary resection increases and the mortality of total pneumonectomy for bronchiectasis in adults ranges from 15 to 30 per cent in the majority of those cases which have been reported in the literature.

Such uniform successes with modern lobectomy and pneumonectomy for unilateral bronchiectasis have established beyond question the desirability of treating the disease surgically. Unfortunately, however, at least 30 per cent of patients with bronchiectasis have bilateral distribution of the disease. A sufficient number of successful bilateral lobectomies has been reported to prove that bilateral extirpation of lung tissue can be accomplished. More experience is necessary, however, to determine which cases should be accepted for such radical surgical treatment. Although the exact precedents for recommending bilateral extirpation of lung tissue are not yet established, the principal considerations are: (1) the age and general condition of the patient, (2) the amount of lung tissue involved, and (3) the degree of involvement and the severity of symptoms.

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CHOICE OF PATIENTS FOR BILATERAL LOBECTOMY

Age and general condition. The age of the patient deserves more consideration in bilateral cases, and it is our opinion that an operation is rarely justifiable in patients past middle age with bilateral disease. The upper age limit will vary in the individual case. The great majority of candidates for bilateral lobectomy, however, will be young, since few victims of extensive bronchiectasis will survive to middle age. Cardiovascular disease and other serious conditions will, of course, preclude the possibility of lobectomy.

Amount of lung tissue involved. A consideration of the amount of lung tissue involved will naturally force the question of how much lung tissue can be removed with a reasonable degree of safety. The experimental work of Heuer and Andrus (4) has demonstrated that dogs live indefinitely with two pulmonary lobes. Later the same authors with their associates, Dunn, Rienhoff, Cave, and others, found that in a dog life was compatible with possession of but one pulmonary lobe.

In man the amount of lung tissue which may be extirpated safely is influenced by a consideration of vital capacity, age, and other individual factors. Reports of successful bilateral lobectomies by Eloesser, Shenstone, and later by Lewis, Churchill, and others and of a successful trilobe lobectomy by Overholt have established clinically that extensive bilateral extirpation of pulmonary tissue is feasible. Recently one of us (3) described the successful removal of even more lung tissue, namely the right middle and lower lobes, and 18 months later the left lower lobe and lingula of the left upper lobe in a boy 16 years of age. This patient is now going to school and is able to engage freely in the usual physical activities

Fig. 1. a, Photographs of patient 3 months after removal of both lower lobes, the right middle lobe, and lingula of the left upper lobe.

without dyspnea or any other physical handicap. Experience with 16 other cases of bilateral bronchiectasis including 4 patients in whom all of the lung tissue was removed except the two upper lobes (the lingula of the left upper lobe was also removed and hereafter will be regarded as the left middle lobe) has convinced us that in young subjects two pulmonary lobes furnish adequate respiratory exchange for ordinary physical activities.

Degree of involvement and severity of symptoms. It has been shown by Perry and King and others, that the severity of symptoms in the individual case of bronchiectasis will almost always parallel the degree of involvement in the bronchiectatic lung, that is, in general, the amount of purulent sputum is in direct proportion to the degree of the bronchial dilatation. The decision to recommend bilateral lobectomy will therefore depend somewhat upon the amount of sputum raised and the inconvenience and disability that the production of foul sputum causes the patient.

In patients of the older age group with bilateral disease and mild symptoms, postural drainage should be given a fair trial before surgical treatment is undertaken. In certain cases, postural drainage may be supplemented by bronchoscopic aspirations. It is our opinion, however, that in young subjects radical treatment is practically always desirable. Children tolerate intrathoracic operations particularly well, and for obvious reasons it is desirable to eradicate the disease before irreparable physical and psychological damage is done.

RESULTS IN 16 CASES OF EXTENSIVE BILATERAL BRONCHIECTASIS

In the group of 16 cases bilateral pulmonary resection was performed in 4 cases. In each of these patients the disease involved all of the pulmonary lobes except the two upper lobes (the lingula of the left upper lobe was also diseased and removed). Two of the patients were 16 years old, one 10, and the other 9. One patient, 16 years old, in whom the right lower and middle lobes had been removed 2 years before the second operation died 3 weeks after the left lower lobe and lingula of the left upper lobe were extirpated. In the bronchiectatic lingula of the left upper removed at operation there was evidence of acute tuberculosis. Death was caused by acute tuberculous pneumonia. The lobes removed at the first operation were re-examined and there was no evidence of tuberculosis. The original diagnosis of bronchiectasis was made by competent physicians at a tuberculosis sanatorium where the patient was sent because of a chronic productive cough. He returned to the same institution to convalesce from the first operation. Apparently pulmonary tuberculosis developed during the interval between lobectomies and was activated by the second operation.

In the 12 remaining cases in which the more severely diseased side was operated on there were 3 deaths, 1 from suffocation on the operating table as a result of sudden flooding of the trachea. Another followed the development of a putrid empyema, the consequence of the opening of the bronchus on the second postoperative day. The early leak in the bronchial stump was undoubtedly the result of hurried operating with gross mass ligation of

Fig. 1. b, Photograph of total amount of lung tissue extirpated.

the pulmonary hilum to prevent the patient from drowning in his own secretions while unconscious from the anesthetic. Both of these casualties were therefore directly or indirectly caused by the flooding of the trachea during the performance of the operation, despite emergency bronchoscopy in the first case and frequent bronchoscopic aspirations during the operation in the second. The third death was the result of a staphylococcus septicemia which followed a minor hemorrhage from the intercostal artery at the site of a thoracostomy tube. This occurred 6 weeks after the operation. The patient's temperature had been normal and he had been out of bed for 2 weeks before this unusual complication became evident. The death was not related therefore to the presence of bilateral bronchiectasis.

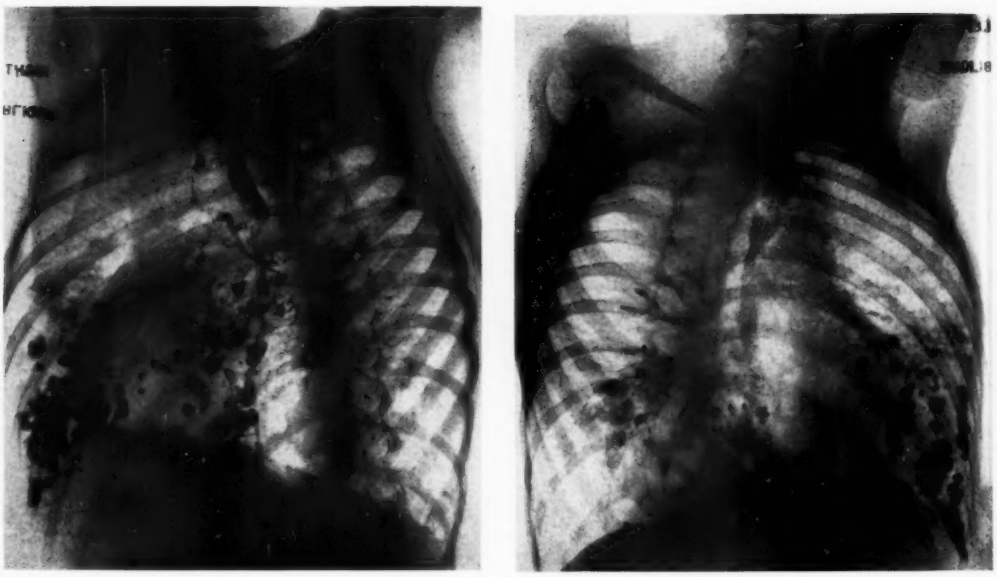
One of the most astonishing features of our cases has been the marked improvement following the removal of the bronchiectatic lung tissue on one side. Several patients have enjoyed such excellent results that they have decided to postpone the operation on the other lung. This is particularly surprising because incomplete removal of bronchiectatic tissue in unilateral cases, in our experience, resulted in complete failure of the operation to relieve the symptoms. The results in 9 patients with bilateral bronchiectasis who have had operations on one side are summarized in Table I

Six of the 9 surviving patients are completely satisfied with the results of the initial operation and have decided to postpone the second operation indefinitely unless the amount of sputum increases. Two patients are greatly improved but are contemplating having the remaining diseased lung tissue removed. In 1 case the extirpation of the right lower lobe was followed by a left empyema thoracis and although the patient has lived for more than a year, he has failed to improve.

The oldest patient in the group (44 years old, Case 2) was operated upon because, in addition to raising foul sputum, he was completely incapacitated by an intractable cough caused by a partial stenosis of the right lower lobe bronchus. From the patient's standpoint, an entirely satisfactory result was obtained by unilateral lobectomy.

It should be emphasized that the best results from unilateral operations in patients with bilateral disease were in patients with far advanced disease on the side operated upon and the less severe disease in the contralateral lung. There was, however, marked improvement in all but 1 case after the first operation regardless of the degree of involvement of the two sides.

In 11 of the 16 patients lipiodol bronchography revealed involvement of both lower lobes, the right middle lobe, and the lingula of



a b

Fig. 2. a and b, Lipiodol bronchograms showing extensive bilateral bronchiectasis. Bronchoscopic examination gave the impression that more pus was originating in the right, a, than in the left, b, lung. Accordingly the right middle and lower lobes were removed first. Three months later the left lower lobe and lingula of the left upper lobe were extirpated. A photograph of the patient a few weeks after the second operation is presented in Figure 5.

TABLE I.—RESULTS IN 9 PATIENTS WITH BILATERAL BRONCHIECTASIS WHO SURVIVED OPERATIONS ON ONE SIDE

Case No.	Age	Lobes diseased	Lobes removed	Results and comments
1	18	Both lower lobes Right middle lobe Lingula of left upper lobe	Left lower lobe Lingula of left upper lobe	Sputum reduced from 200 to 300 c.c. daily to about 30 c.c.
2	44	Both lower lobes Right middle lobe Lingula of left upper lobe	Right lower and right middle lobes	Intractable cough relieved. Sputum reduced from 50 to 60 c.c. to about 10 c.c. daily
3	10	Both lower lobes Right middle lobe Lingula of left upper lobe	Right lower and right middle lobes	Sputum reduced about 50 per cent. Produces about 20 c.c. daily since operation. Probably will require operation on left side
4	19	Both lower lobes Right middle lobe Lingula of left upper lobe	Left lower lobe and lingula of left upper lobe	Symptom free for 2 years, except for 5 to 10 c.c. of sputum each morning
5	30	Both lower lobes Right middle lobe Lingula of left upper lobe	Right middle and lower lobes	10 to 15 c.c. of sputum daily since operation. About 75 per cent reduction in amount since operation
6	18	Left lower lobe Right middle lobe	Left lower lobe	Small amount of sputum (about 5 c.c. in winter time) since operation
7	19	Left lower lobe Lingula of left upper lobe and right middle lobe	Left lower lobe and lingula of left upper lobe	Last report about 18 mo. ago. Small amount of sputum (teaspoonful) in the morning. Produced large amount of foul sputum before operation
8	26	Left lower lobe and right middle lobe	Left lower lobe	Practically no sputum for 1 year after the operation. Sputum now about 10 c.c. daily
9	22	Both lower lobes	Right lower lobe	Failure-Developed empyema on left. Condition too poor to proceed with second operation

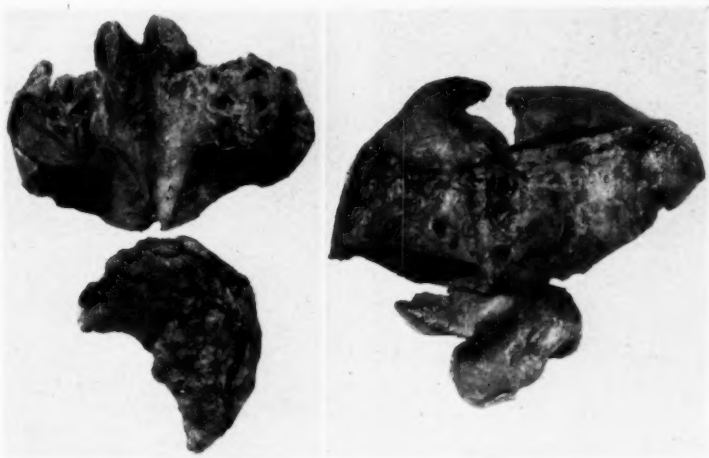


Fig. 2. c, Photograph of pulmonary tissue removed.

the left upper lobe. In the 5 remaining patients the distribution of the disease was as follows: left lower lobe and right middle lobe, 1 case; left lower, left middle (lingula), and right middle lobe, 2 cases; and both lower lobes, 2 cases.

Our practice has been to eradicate the involved lung tissue on the side most extensively diseased and attack the other side later. In a few cases it was rather difficult to decide which lung was more extensively diseased by the appearance of lipiodol bronchograms. The impressions gained by bronchoscopic examinations were relied upon to determine the major source of pus in these cases (Fig. 2).

THE PRINCIPAL HAZARDS OF BILATERAL PULMONARY RESECTION

Suffocation. The principal immediate risk of pulmonary resection, whether it be for unilateral or bilateral bronchiectasis, is suffocation during the performance of the operation. The bronchiectatic lung tissue constitutes a cesspool of putrid secretions whose only exit is through the tracheobronchial tree. If the disease is bilateral, two reservoirs of purulent secretions must either drain through the trachea or remain pooled in the lung. The trachea is in fact a relatively small caliber tube, yet it is the only airway through which the respiratory exchange can be maintained. During the administration of an inhalation anesthetic, it is also an essential passageway for the anesthetic gas. The head-down position is advantageous for postural drainage in the conscious patient and does aid in emptying the lungs of pus as long as the cough reflex is intact. Lowering the head of an unconscious patient whose lungs are filled with secretions, however, increases the danger of suffocation by flooding the trachea. It becomes apparent, therefore, that the conventional lobectomy position with the head and trunk lowered to the horizontal level, has two distinct disadvantages: (1) secretions will gravitate into the trachea and interfere with the administration of the anesthetic agent; (2) the contralateral or "good" lung is dependent and its bronchial orifices in a position to be flooded by the secretions during the time it must carry the major load of respiratory exchange (Fig. 3).

Experimental work by Schlaepfer, illustrating the increased danger of fatal air emboli when air is injected into a pulmonary vein with an animal in an erect or semierect position, has undoubtedly influenced thoracic surgeons to perform operations with the patient's head and trunk lowered to minimize the danger of the influence of gravity if air embolus should occur. It has been demonstrated by Moore, however, that the chief source of danger from air embolus is not to the cerebral

a

b

Fig. 3. a, A lipiodol bronchogram demonstrating distribution of 5 cubic centimeters of lipiodol with the patient in the upright position. b, An x-ray film of the same case 3 minutes after being placed in the position usually employed for lobectomy. The oil has flowed into the trachea and dependent lung. In patients with "wet" bronchiectasis suffocation may be caused if pus is allowed to accumulate in the trachea and contralateral lung. This is particularly true when the chest is opened widely during the performance of intrathoracic operations.

vessels but the collection of air in the coronary vessels of the heart. The same conclusions were reached by Kent and Blades who repeated Moore's experiments and also found that the position of an animal had little or no effect when air was injected into the pulmonary veins. Moreover, air embolus from lobectomy is a relatively infrequent accident as compared to the complications caused by suffocation from flooding the trachea and dependent lung when the conventional position for the operation is employed.

THE UPRIGHT POSITION FOR LOBECTOMY

The decision to perform a lobectomy with the patient in the upright position to minimize flooding of the tracheobronchial tree was made by strict necessity in a patient who could not tolerate a completely flat or horizontal position when fully conscious. It was even necessary to perform preoperative bronchoscopies in an upright position to prevent suffocation. Bilateral extirpation of all lobes (including the lingula of the left upper lobe) except the two upper lobes was accomplished in two stages without difficulty and the patient enjoyed an uneventful convalescence after both operations (B. B.) (Fig. 4).

Since the surprising success in this difficult case, the upright position has been employed on 7 occasions in extremely "wet" cases and it has been possible to proceed with the pulmonary resection with deliberate and precise operating unhampered by frequent aspirations through the intratracheal catheter or by the necessity of an emergency bronchoscopic aspiration to prevent suffocation. Technical difficulties are not increased and the exposure is excellent. The usual posterolateral incision has been utilized with a technique identical to that employed when the patient is in the conventional horizontal position.

One logical objection to performing a major operation with the head raised might be the danger of shock. Surgical shock was not manifested in any of the 7 patients operated upon in the upright position. If, however, it should occur it would be safe to lower the head and trunk provided facilities for bronchoscopic aspiration were immediately available to clean out the trachea when the position of the patient was altered.

Before the upright position was employed in unusually wet cases we placed a large premium on speed in operating upon patients with bilateral disease. We have been gratified to find that in patients who remained upright sufficient time was available to accomplish separate ligation of each structure in the pulmonary hilum. This is of tremendous importance in dealing with bilateral bronchiectasis because a leak in the bronchus immediately or soon after the operation constitutes a much more serious problem in patients with bilateral disease than in individuals with a sound contralateral lung. Actually the ultimate success of the operation, particularly the first one, may depend on a rapid and smooth convalescence.

POSTOPERATIVE CARE AND COMPLICATIONS

In patients with bilateral bronchiectasis re-expansion of the remaining lobes becomes of tremendous importance particularly at the time of the second operation. The respiratory exchange must depend upon the upper lobes and failure of re-expansion or atelectasis might be fatal. We have maintained, therefore, an upright position during the postoperative period, thus keeping the pleural cavity on the side operated upon completely free from fluid by catheter drainage with suction. This allows the remaining lung tissue to re-expand rapidly. Placing the patients in a horizontal position with the side operated upon down and thereby allowing dependent drainage is not desirable in instances of bilateral disease because secretions from the contralateral lung will collect in the trachea. The remaining lung tissue has expanded within a few hours when the upright position is maintained, and we find that the patients are more comfortable when upright.

Fig. 4. Photograph of a patient in the upright position for lobectomy.

Fig. 5. Temporary manual immobilization of the thoracic cage to aid coughing, an important feature in the postoperative care of lobectomy patients.

The other features of the postoperative care involve attention to the same details which are important following any major thoracic operation.

Routine postoperative bronchoscopy before the patient reacts from the anesthetic is of paramount importance. In this way the secretions which have accumulated in the contralateral lung during the operation can be partially emptied. Temporary immobilization of the thoracic cage, during the act of coughing, as soon as the patient is awake, may

be produced by the nurse exerting pressure on the lower costal margin with her hands (Fig. 5), this will allow coughing without undue pain and further insures against accumulations of secretions.

A complication which seems to be peculiar to patients with bilateral disease is the development of pleural effusions on the side not operated upon. This has occurred in 3 cases. In 2 instances the effusion did not become infected and cleared rapidly. In the third case empyema thoracis developed (Case 9, Table I). One patient with extensive bilateral disease (both lower lobes, right middle and left middle or lingula) developed a lung abscess in the right middle lobe 6 months after the removal of the diseased tissue on the left side. The abscess disappeared after 3 weeks of bed rest and postural drainage. There are no residual symptoms.

Serious infections of the pleura following a leak in the bronchus soon after the operation have, in our experience, constituted the most serious postoperative complication in both unilateral and bilateral lobectomy cases. Permanent closure of the bronchus is therefore the most important single factor in preventing the serious consequences of a complicating putrid empyema.

Separate suture of the bronchus and individual ligation of the vessels when feasible will insure a low incidence of serious postoperative empyemas. There are cases in which induration at the root of the lobe will preclude an attempt to dissect out each structure. Even in these cases, however, a reasonably good repair of the bronchus can be accomplished if a slapdash mass resection can be avoided. In the 7 patients operated upon in the upright position precise operating was possible because the danger of suffocation from flooding of the tracheobronchial tree was controlled.

CONCLUSIONS

1. Experience with 16 cases of bilateral bronchiectasis suggests that in young subjects surgical treatment should be recommended if the two upper lobes are free of disease (the lingula of the left upper lobe is considered as the left middle lobe).

2. Practically all patients with bilateral bronchiectasis will be benefited by extirpation of the bronchiectatic tissue on the most extensively diseased side. When the contralateral disease is not far advanced, unilateral lobectomy may at least temporarily relieve the production of purulent sputum.

3. In 3 young subjects all of the pulmonary tissue except the two upper lobes (lingula of the left upper lobe was also extirpated) has been removed successfully.

4. Twenty lobectomies have been performed in patients with bilateral bronchiectasis. Four patients died. Two deaths had no connection with the bilateral distribution of the disease.

5. The chief danger from bilateral lobectomy is suffocation during the operation or from early opening of the bronchus. The upright position for lobectomy is suggested to minimize the danger of suffocation while the operation is in progress, to relieve the necessity of rapid operating, and to allow time for adequate closure of the bronchus.

REFERENCES

1. Churchill, E. D. J. Thorac. Surg., 1936, 6: 286.
2. Eloesser, L. Surg. Gyn. Obst., 1933, 57: 247.
3. Graham, E. A. Surgery, 1940, 8: 239.
4. Heuer, G. Bull. Johns Hopkins Hosp., 1922, 33: 130.
5. Kent, E. M., and Blades, B. B. J. Thorac. Surg. (in press).
6. Lewis, I. Brit. J. Surg., 1936, 24: 362.
7. Moore, R. N., and Braselton, E. W., Jr. Ann. Surg., 1940, 112: 212.
8. Overholt, R. H. J. Am. M. Ass., 1937, 109: 127.
9. Perry, K. N. H., and King, D. S. Am. Rev. Tuberc., 1940, 41: 531.
10. Schlaepfer, K. Surg. Gyn. Obst., 1923, 37: 519.

END-RESULTS IN ONE HUNDRED CONSECUTIVE CASES OF BRAIN ABSCESS

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THE three problems to be solved in an attack upon a brain abscess are when, where, and how to operate. Increased clinical experience with this lesion plus the use of ventriculography and other technical aids have made diagnosis and localization relatively simple. But determination of the proper time to attack an abscess and selection of the appropriate procedures for drainage requires the nicest surgical judgment. Only too often the initial feeling of satisfaction in the surgeon's mind over an apparently successful outcome is abruptly shattered by the appearance of some unexpected and possibly disastrous complication.

A study of the records of one hundred consecutive cases of subcortical abscess of the brain seen in the neurosurgical clinic of the University Hospital form the basis of this report. Little stress will be laid upon etiology, types of organism, or methods of diagnosis and localization unless these factors bear directly upon the surgical results. These cases were seen between January 1, 1926 and January 1, 1940. An adequate follow-up over a number of years is, therefore, available in many of the survivors.

Of these 100 cases, 47 recovered and 53 died. Ten patients died before any operative procedure could be instituted, 7 within 12 hours of admission to the hospital, 3 within 48 hours. These last 3 cases were all seen prior to 1930 when the value of ventriculography in the localization of the lesion was less clearly recognized. Nine patients had meningitis as indicated by lumbar puncture findings prior to operative intervention. Surgical attack upon the abscess was undertaken as a last resort. In 6 evacuation was successful and in 3 the lesion was found at autopsy. All of these fatalities occurred prior to 1937. The use of the appropriate sulfaderivatives, had they been available, might well have saved half of this group. In 9 patients multiple abscesses were present. One or more of these lesions were adequately drained in 7, in 2 the evacuation of pus was unsatisfactory. In 7 of these patients the abscesses were so widely separated, parietal and cerebellar, frontal and occipital, right and left frontal, frontal and parietal (3), right and left cerebellar, that formation of a second adjacent abscess following bad drainage of the original cavity seemed impossible. In 2 cases, one of multiple frontal and another of multiple cerebellar abscess, it is conceivable that inadequate drainage of the primary abscess may have resulted in a spread of infection and the formation of a second cavity. The 25 remaining fatal cases are grouped together under the general heading of "bad operative technique" as the cause for the mortality. It is from an analysis of this group that we hope to find the errors in operative methods. In all these cases the surgeon had every opportunity to save the patient; in none was any great emergency present, and the operative procedure was planned and carried out deliberately in the manner he considered to be the best adapted to the problem at hand.

What are the particular problems connected with the surgery of brain abscess? The brain lies within the close confines of the skull; therefore, an increase in intracranial pressure may appear before or after operation and must be promptly and adequately relieved. The entire brain is surrounded by the subarachnoid space containing the cerebrospinal

TABLE I.—100 CASES BRAIN ABSCESS VERIFIED

	Cases	Per cent
Died	53	
Recovered	47	
Not operated upon, died	10	19
Causes of death		
Meningitis before operation	9	17
Multiple abscesses	9	17
Bad surgical management	25	47

Annual Oration of the Philadelphia Academy of Surgery, October 13, 1941.

TABLE II.—OPERATIVE STATISTICS

	Died	Recovered	Per cent
Closed drainage	16	32	66
Open drainage	6	12	66
Enucleation	3	3	50
Totals	25	47	

TABLE III.—OPERATIVE TECHNIQUE
47 RECOVERIES

	Cases
Tap and drain	24
Tap only	8
Wide drainage	12
Enucleated	3
Total	47

fluid. Furthermore, those areas of the brain overlying the abscess must be traversed by the drainage tract. Again, the abscess may tend to burrow down toward, and rupture into, the ventricle. Prevention of infection either before or after drainage, therefore, is a problem. Lastly, since certain cortical areas of the brain overlying many an abscess have important functions, evacuation of the cavity with a minimum of destruction of the cortex is essential if recovery without motor or sensory loss is to be accomplished.

All neurosurgeons agree that if possible an abscess should not be attacked until encapsulation has occurred. Three to 4 weeks from the onset of symptoms, therefore, should be permitted to elapse before the cavity is evacuated, although that certain abscesses will never become encapsulated is frankly conceded. The use of sulfaderivatives has largely overcome the dangers of infection. The proper way to handle the problem of increased intracranial pressure and the amount of destruction of adjacent brain tissue and overlying cortical areas justifiable to secure adequate drainage are the outstanding points at issue. If intracranial pressure is to be relieved and adequate open drainage of the abscess under direct vision assured, a large opening must be made in the bone and overlying cortical areas and brain tissue adjacent to the abscess destroyed. This may well result in impairment of function and the large scarred area in the brain may subsequently cause convulsive attacks. But if only a small trephine opening is made, the abscess simply tapped and drained to minimize injury to the surrounding brain, the drainage may be inadequate or the intracranial pressure persist with fatal results.

TABLE IV.—CAUSES OF DEATH
AFTER CLOSED DRAINAGE

	Cases
Increased pressure	7
Cerebritis	6
Meningitis	3
Total	16

TABLE V.—CAUSES OF DEATH
AFTER OPEN DRAINAGE

	Cases
Meningitis	5
Cerebritis	3
Vascular injury	1
Total	9

TABLE VI.—CAUSES OF DEATH FOLLOWING "BAD OPERATIVE TECHNIQUE"—25 CASES

	Cases
Cerebritis	9
Meningitis	8
Increased pressure	7
Vascular injury	1
Total	25

TABLE VII.—COMPARISON OF RESULTS IN "CLOSED" AND "OPEN" TECHNIQUE

	Cases
Cases followed	41
Dead	2
Lost	4
Closed technique	
Tapped or tapped and drained	29
Complete recoveries	22
Complication	7
Open technique	
Wide drainage	12
Complete recoveries	3
Complications	9

Curiously enough in this series, 48 cases were handled by a closed drainage with 32 recoveries and 16 deaths, a 33 per cent mortality, while 18 cases had a larger opening made for open drainage, with 12 recoveries and 6 deaths, a 33 per cent mortality. The advocates of open drainage may well claim that had more of the 48 patients treated by closed drainage been widely opened, the mortality might have been lower. In this group of 16 fatal cases, in 6 following tap and difficulty in insertion of the drainage tube, autopsy showed a marked cerebritis about the abscess. In every instance the abscess was deep seated, small and encapsulated. Five of these lesions were cerebral, 1 right frontal, 1 right temporal,

1 left frontal, 2 in the left temporal region, and 1 in the cerebellum. Admittedly these small deep seated encapsulated lesions are hard to handle by any method. The left frontal and temporal areas are too important physiologically to justify free excision. A cerebellar abscess is difficult to drain widely because of the heavy muscles attached to the occipital bone. The two lesions in the right cerebral hemisphere might have been saved by section of the cortex. In 7 patients with relatively superficial lesions apparently adequately drained by simple trephine, death was attributed to increased intracranial pressure, on clinical evidence in 4 instances and at autopsy in 3. Two of the 3 cases at autopsy had cerebral, 1 a cerebellar abscess. No meningitis was noted nor was there an unusual amount of cerebritis present about the lesion. The striking feature in each case was a pressure cone about the cerebellar tonsils. Admittedly these 7 cases might have been saved by a wider opening in the bone with cortical section and more ample drainage or by the addition of a contralateral decompression to the operative procedure for the purpose of reducing intracranial pressure. In 3 instances postoperative meningitis was the cause of death; due in 1 case to rupture of the abscess into the adjacent ventricle, and in 2 to infection presumably of the subarachnoid spaces about the drainage tract.

The 6 deaths following open drainage with a wide craniectomy and cortical incision, all in cerebral lesions, were caused in 2 instances by the development of uncontrollable brain fungus, meningitis in 3 patients, and inanition in a single case after a 3 months' struggle.

The 3 fatalities consequent upon an attempt at complete enucleation of the abscess were due to meningitis consequent upon its rupture during removal in 2 instances. In the third, a large, chronic, encapsulated abscess of the left middle fossa, the middle cerebral vessel was adherent to the lesion and was torn during its removal. The wound healed well, no meningitis could be demonstrated, but the patient died about 2 months later as a result of the vascular injury.

Of the 47 patients that recovered, 24 were tapped and a drain inserted; 8 were tapped without permanent drainage. In 12 wide drainage by craniectomy and cortical section was instituted. In 3 complete enucleation of the abscess was successfully accomplished.

This brief review of the surgical methods used suggests definitely that the tendency here has been toward conservatism as to the destruction of brain areas overlying or adjacent to the abscess in establishing drainage.

In support of this conservatism the follow-up statistics furnish important information. Forty-one cases have been followed, 4 are lost, and 2 are known to be dead from outside causes. Among 29 cases treated conservatively by tap or tap and drain, 22 have completely recovered and, as far as our information goes, have returned to their original economic status. Seven patients have neurologic sequelae, weakness or convulsive attacks, which have seriously crippled their wage-earning power. In 12 patients in whom deliberately or through necessity a craniectomy was performed with cortical destruction for more adequate drainage, but 3 have made complete recoveries, and 9 have sequelae of such a nature that they are seriously handicapped economically.

As a result of this study the conclusion seems unavoidable that conservative treatment, tap or tap and drainage through a small trephine in the bone, produces the better results in the long run in the treatment of brain abscess. The use of wide open drainage has not, in this series at least, lowered the operative mortality in comparison with more conservative methods. A careful follow-up in this group of cases indicates that a much higher proportion of patients are returned to their former occupation following the use of simpler procedures for instituting drainage than when a more radical technique involving wide destruction of brain tissue is employed.

We feel, therefore, that the initial attack upon a brain abscess should be carried out through a small trephine opening with the insertion of a drainage tube. This will result in a cure in many instances. If this technique does not produce satisfactory results, a resort must be had to more radical methods involving the patient in a greater hazard from serious neurologic sequelae.

MECHANICAL SKELETAL FIXATION IN WAR SURGERY

Report of Sixty-one Cases

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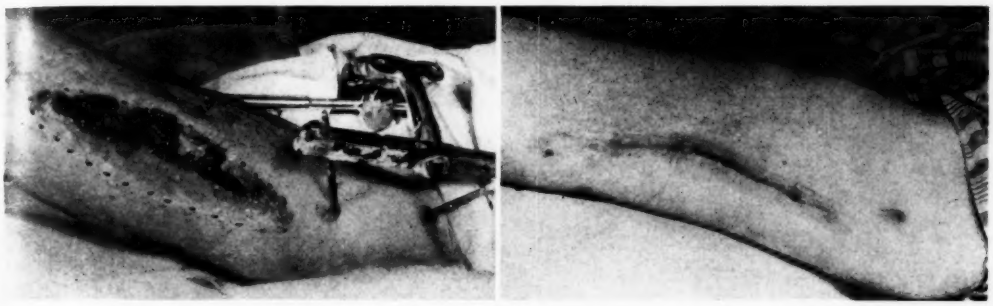
WAR conditions do not create new or unknown fracture problems—but they will often multiply the problems in the individual patient. During the course of a year, every imaginable type of fracture is likely to be seen at a busy civilian hospital; but among war casualties, frequently the complicated fractures occur in combination which greatly increase the difficulties of treatment. On top of this the theater of war comprises an environment less favorable for treatment than exists in civilian hospitals. The operating rooms are less adapted to careful asepsis, the crowding of patients on wards threatens a higher rate of cross infection, and the personnel of hospital staffs may be more pressed for time by the rush of cases, and may in themselves be less efficiently trained than would be desired under normal conditions. Consequently, the problems of war surgery arise largely from the combination of these two factors: multiplicity of complicating injuries and less favorable environment for treatment. Under these circumstances, we may tend to adopt slightly more radical methods of treatment, but before doing so, we must insist upon one elementary point. We must be sure the pretext of emergency conditions does not lead us into the fatal error of adopting an *easier* method rather than a *better* method. If we change to radical measures, we must make certain that they are reasonable measures. Even in critical stages of a war, the principles of our treatment must be kept sound.

These considerations were kept in mind in 1940 when among the equipment provided for the American Hospital in Britain was included apparatus for the mechanical skeletal fixation of fractures of the types devised by Roger Anderson and Haynes. As the apparatus had never before been used for the treatment of air raid and battle casualties, it was felt that the indications and contraindications for its use must be carefully studied. It was recognized that the apparatus offered many possibilities for improving the treatment of difficult cases. At the same time the possibility of misuse or abuse of the method was appreciated. In general two rules were applied to guard against this latter danger. The first, and most important rule, insisted that the apparatus was to be applied only by qualified surgeons who thoroughly understood the principles on which it was based and had carefully studied its mechanism. Not all of the staff had had personal experience with its use, but all had familiarized themselves with its practical workings as well as theoretical purposes. Unless this point is stressed, the use of the apparatus is likely to prove more dangerous than beneficial. Second, the rule was also adopted, that the method should be applied only to cases in which treatment by simple, conservative lines seemed likely to prove inadequate. In other words, mechanical fixation was never used routinely or universally, but was reserved for selected cases. Here again, the point should be stressed, that a thoughtless and indiscriminate use of this method would be wholly unwarranted. Like any other method of treatment, its success depends entirely on the judgment and the skill of the surgeon who employs it; for, no matter how mechanical it may appear, it cannot pretend to convert the art of surgery into a machine trade.

The principles behind mechanical skeletal pin reduction and fixation were originally based upon very sound reasoning and have already been presented in the literature. Many appliances have been designed to carry them out—all more or less derived from the underlying purpose of fixing the injured bone above and below the fracture by means of pin units. The pin units make possible a mechanical reduction with the most efficient utilization of the reducing forces, and with greatly increased accuracy. Once the reduction is obtained, the pin units can be fixed together by means of plaster or of bars which incorporate them into a single, immovable vise. Thus they prevent further motion at the fracture site without necessitating the immobilization of joints above or below the injury.

A discussion of the mechanism by which this is accomplished would go beyond the scope of the

The work reported here was carried on with the help of the staff of the American Hospital in Britain, including Wallace Cole, professor of orthopedic surgery, University of Minnesota; Frederick W. Waknitz, W. Richard Ferguson, Donald E. Dial, Norman Egel, Harry Hall, Dudley Smith, James Bateman.



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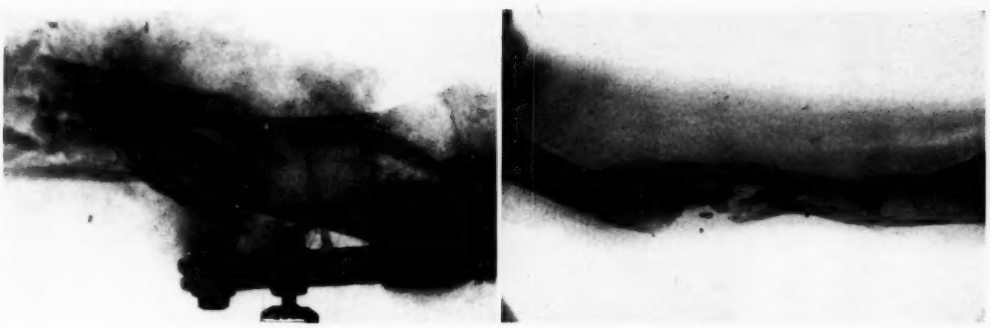

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Fig. 1. a, External aspect of through-and-through wound of the thigh which was caused by bomb fragment —deeply infected by staphylococcus, streptococcus, and Bacillus welchii. Dotted line shows the original area of the wound. Left photograph shows healing after 3 months. Second photograph shows the same wound with complete epithelialization after 6 months. Treatment was carried out by means of Anderson pins and plaster, with bar for fixation. b, Gross shattering of femur is shown in left roentgenogram. View on the right shows healing (without bone graft), as callus united across splintered fragments in a period of 6 months.

present article; but it may be said that in the cases treated by the staff of the American Hospital, the Anderson apparatus was largely used. It had the dual advantages of being comparatively easy to apply and control and of having a universal adaptation to many different varieties of fractures. A number of cases in this series were treated by Haynes' apparatus, which also gave excellent results. In addition, the principles of the Anderson apparatus were adapted by Waknitz to a miniature device for use on small bones; and in 6 cases this Waknitz apparatus was used. All in all, it seems clear from our experience that the technical aspect of equipment for mechanical skeletal fixation is still in its infancy and that great improvement may be expected along these lines.

APPLICATION TO INFECTED FRACTURES

Among the fracture complications which occur in war surgery, three common types will prove especially difficult to handle by any of the established forms of treatment. The first of these groups, and the commonest, is the deeply infected compound fracture. In cases in which there is no tendency toward displacement, such fractures may often be treated satisfactorily with Orr's closed-plaster technique; and prolonged, undisturbed immobilization will almost always yield good callus. On the other hand, if the fracture is comminuted or so oblique that it tends to slip, the simple closed-plaster treatment will end in malposition and malunion. No external splint can be relied upon to prevent displacement. Such fractures, therefore, would justify open reduction followed either by plating or bone-grafting; but the presence of infection contraindicates this procedure almost completely. The only adequate method of treatment left among conservative measures, is the use of skeletal traction; but this in itself entails three serious hazards. Even when combined with the use of a plaster casing, any

Fig. 2. This double, compound fracture of the tibia and fibula left an anterior wound which could not be drawn together. The fracture was fixed in perfect alinement by Anderson pins; and a sliding skin flap was carried up to close the wound. A week later, the area on the medial aspect of the calf was covered by a free skin graft as shown in this photograph. The procedure did not disturb the fracture reduction which was held by a fixation bar.

form of traction must necessarily involve motion and irritation at the fracture site, inasmuch as the weight at the foot of the bed is counterbalanced by the patient's body weight. The patient moves about in bed, and no matter how well balanced his traction may be, he persistently alters and upsets the tension upon the fracture site. This constitutes a repeated and more or less incessant violation of Orr's principle of complete rest, and thus tends to prolong the activity of the infectious process. Then also, the fact that alinement has to be maintained by traction suggests that there will often be a recognizable factor of distraction whenever the pull and counterpull are altered by body movements. Since infected fractures are notorious for their high incidence of nonunion, this distracting tendency must be regarded as a really serious risk. In many cases it may even be the true cause of the nonunion, unless it is properly checked by the most vigilant care aided by frequent x-ray control, neither of which may be easily available in emergency army hospitals. The third disadvantage of applying traction to infected fractures is that it necessitates a total immobilization of the patient's whole body and thereby wastes all his muscles, decalcifies his bones, depresses his metabolic processes, and invites the formation of urinary calculi. Experience among a number of such bedridden patients has convinced all of us that this danger is more than a theoretical one and that it must be actively guarded against.

The use of mechanical skeletal fixation in such cases offers many advantages. The pins can be applied above and below the infected fracture site, and enough clean skin surfaces can usually be found on one side of the limb or another to permit this introduction aseptically. It might at first be supposed that infection would spread through lymphatic channels and contaminate the

STATISTICAL ANALYSIS OF SIXTY-ONE CASES TREATED BY MECHANICAL FIXATION AT THE AMERICAN HOSPITAL

TABLE I.—CASES WITH EXISTING INFECTION PRECEDING PIN FIXATION

	Cases
Clean cases	43
Infection definitely present but not a major complication	6
Infection present as a serious major complication	12
Total	61

TABLE II.—AGE OF FRACTURE AT TIME OF TREATMENT

	Cases
Early—up to 1 week	16
Intermediate—from 2d through 4th week	30
Late—from 5th through 10th week	6
Delayed union established—from 3 mo. to 6 mo.	8
Correction of malunion—4 mo. old	1
Total	61

TABLE III.—ANATOMICAL DISTRIBUTION OF CASES

	Cases
Long bones of lower extremity	
Femur	30
Tibia-fibula	16
Long bones of upper extremity	
Humerus	3
Forearm	6
Miscellaneous	
Mandible	1
Metacarpal	5
Total	61

TABLE IV.—INCIDENCE OF INFECTION FOLLOWING PIN FIXATION

Cases	Superficial drainage—ceased with removal of pins	Infection in pin tracts	Infections in fracture site	
			Healed	Sinus continued draining
43 clean cases	Common where soft tissues pulled on pins	None	—	—
6 cases with pre-existing infection (minor)	Ditto	None	6	0
12 cases with pre-existing infection (major)	Ditto	1	7	5

pin tracts. However, this danger does not materialize if the pins are properly applied. The design of the Anderson pins from converging angles, makes it impossible for them to pull in or out through the cortical bone. Thus any irritating motion or instability is eliminated. In fact, such dual pin units are much safer, from the standpoint of infection, than single Steinmann fixation pins whose tendency to slide back and forth is unchecked. In our experience many of the latter, which were sent in to us from other hospitals, formed infected sinus tracts which took months to heal; whereas the dual pin units, with only one exception, healed within a day or two of the withdrawal of the pins. However, if the dual pins are improperly applied and fail to pierce both cortices of the bone, they will then develop a certain amount of motion which duplicates the danger of the single Steinmann pin.

Once pins have been applied and locked together with a bar, the fracture has gained the complete immobilization needed to protect against irritation of the infectious process (Fig. 1). The soft tissues can then be given the protection and support of a plaster cast, which will assure the fullest advantage of the Orr treatment. Whenever it becomes necessary to change the cast, in the course of weeks or months, the pin units, fixed to their bar, will continue to protect the fracture itself against any disturbance. On the other hand, if the occasion should arise for dressing the wound, or even applying a skin graft (Fig. 2), the use of pins and bar renders the fracture easily accessible without in any way endangering its position. For surgeons who prefer repeated antiseptic dressings rather than closed-plaster treatment, this is a very great advantage. In one of our cases, drainage from an already infected fracture site became blocked and the infection flared up while pins were in place. Without interfering with the pins, it was possible to incise the mouth of the sinus and evacuate a large abscess cavity around the fracture. Pin fixation was continued uninterruptedly, and both the sinus and the fracture eventually healed.

APPLICATION TO SHOCK CASES

It will often happen that the fractures of war surgery will be complicated by moderate or severe shock. This may arise from simple loss of blood, or from associated injuries in the head, chest, or abdomen. Or it may be that multiple fractures have occurred and have caused excessive hemorrhage into the muscles. One such case in our series, suffered from 17 fractures; and the hemorrhage into his soft tissues was so extensive

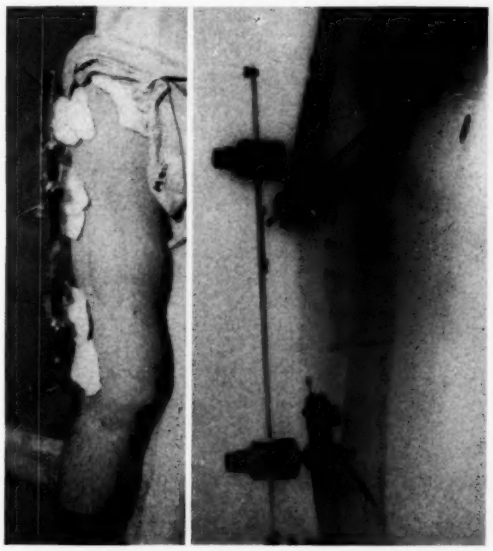


Fig. 3. The photograph shows anterolateral line of incision for bone grafting a fractured femur which was 6 months old and showed no sign of union. Pins were inserted posterolaterally—out of the way of the operation. Roentgenogram shows ilial bone graft in place. Solid union occurred in 4 months during which time the patient was ambulatory.

that his red blood corpuscles had fallen to 2,000,000 and his hemoglobin to 45 per cent. In such cases, any indications for operative treatment by open reduction must be followed with extreme caution; and very often must be postponed for weeks at a time. During the interval of delay, the use of spica casts for immobilization is often impossible, while at the same time treatment by traction greatly complicates bed-care and fails to make the patient comfortable. The use of mechanical fixation, however, involves practically no surgical risk. Pins can be applied if necessary, without even moving the patient out of bed. Once the pins are locked to the fixation bar, the pain of the fracture is relieved and the patient is free to move about in bed. If some other form of surgery does become necessary, the fracture itself no longer proves to be any problem or contraindication.

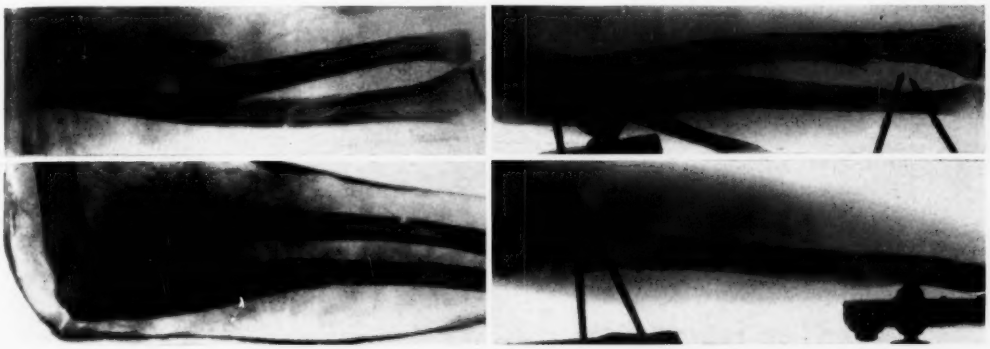
Often the patient is too weak at the start for a painstaking reduction of his fracture; but with the use of the fixation bar a simple, primary reduction can be carried out and locked in place. This will counteract further shortening due to muscle spasm, and will eliminate the shock that results from motion of the fracture ends. Thus

a b c

d

Fig. 4. Snapshots of patients wearing mechanical fixation apparatus. b, This soldier has a fractured femur as well as tibia and fibula. The group includes a patient in a wheelchair who had lost his left arm as well as shattering his right femur and who learned to walk with one crutch and became ambulatory 6 weeks after pin fixation.

immediate relief is administered, with the advantage that at a later stage the limb can again be placed in the reducing apparatus and the alinement improved, often without the necessity of an anesthesia, and the reduction can be completed extremely simply, proceeding on from the primary pin fixation which has already been performed. In the meanwhile, the patient's fracture has been completely immobilized, and he has been rendered more safely transportable than any other method could accomplish. From this standpoint, the use of the fixation bar is a most important adjunct to treatment, and has a great advantage over simple plaster casing.



a

Fig. 5. a, Dislocation of head of radius and fractures of radius and ulna which had resisted two previous attempts at simple closed reduction but yielded easily to mechanical reduction. Elbow was immobilized in plaster for 3 weeks, following which free motion was allowed and nearly normal range was gained. Pins were removed after 12 weeks, when callus was solid. Full elbow motion was then regained almost at once. b, Same patient with arm encased in plaster-of-Paris but with external fixation bar.

b

APPLICATION TO OLD, DEBILITATED PATIENTS

Under war conditions, not a few cases will be found when the patients have suffered almost as much from their fracture treatment as from the fracture itself; and this, without criticism of the surgeons or Casualty Clearing Stations where they have previously been treated. Facilities for adequate treatment of difficult fractures may not be available at the smaller centers, and at the same time opportunities for transfer may be hard to arrange. The inevitable result is that weeks or even months may pass before the patients reach a place of final treatment. Table II of our charts illustrates the fact that only about one quarter of our series of patients reached our base hospital within the first 2 weeks. The largest proportion were therefore already in a stage in which fractures become relatively difficult to correct. Of this group, it will be noticed that almost one-third were approaching the stage of delayed union. The debility associated with prolonged rest in bed has already been noted, and is increasingly important as the months go by. As well as being a physical handicap, it also becomes a mental and moral discouragement. At this stage, it is common for surgeons to accept the necessity of grafting the bone; but after a grafting operation has been performed a further period of long immobilization in plaster spicas often proves necessary, and in itself detracts from the chances of success. On the other hand, the use of mechanical pin fixation combined with bone grafting will provide sufficient stabilization to encourage callus formation, while at the same time, the patient immediately becomes ambulatory. This treatment is illustrated in Figure 3, showing a patient with a 6 month old fracture which was first pinned to permit him to become ambulatory, and then grafted with a piece of the ilium. During the post-operative months he continued to be ambulatory and his general condition and muscular development improved, while he gained solid union of the fracture.

At first we questioned the amount of ambulation which would be possible while the patients were wearing apparatus; but in practice, our doubts were soon dispelled. One of our patients, a Polish sergeant pilot, with fractures of both bones of his lower leg, as well as his femur, made a practice of walking three-quarters of a mile up to a mile and one-half daily with crutches. This started 3 weeks after pins were inserted and continued throughout his convalescence. A number of these patients were transferred to convalescent

Fig. 6. Old malunion of 4th metacarpal treated by the Waknitz apparatus. Patient also had a fractured ankle; but was able to use this hand for crutches throughout convalescence. He also stitched embroidery for occupational therapy with this (right) hand.

homes for much of the convalescent period, and all of them were ambulatory to a degree that would have made their immediate evacuation to other hospitals a matter of the greatest ease (Fig. 4). This factor, in war surgery, proves of great importance, especially with respect to femoral fractures which are so helpless when tied to Balkan frames. Reports from the British army's evacuation of France show that most of their femur cases had to be left behind to be taken prisoners.

DISCUSSION OF APPLICABILITY TO DIFFERENT BONES

The advantages of mechanical fixation in general apply with particular force to fractures of the femur (see Table III). Though we realize that these fractures can be successfully treated by simple traction, it must be admitted that a high percentage of failures and of delay in union does occur. This will be especially true under war conditions where a strict watch over the patient and continued x-ray control may not be easy to provide. In civilian practice, many surgeons advocate open reduction of these fractures; but even this does not yield the advantage of ambulation.

More and more, therefore, do we come to the conclusion that the use of mechanical pin fixation, even on simple fractures of the femur, will be thoroughly justified in military practice.

The same considerations do not apply to fractures of the tibia and fibula; both for the reason that they can get about in a long leg cast after bone grafting or plating, and because many of the transverse fractures can be adequately controlled by a simple reduction and skin-tight plaster casts. On the other hand, fractures of these bones are particularly easy to treat by mechanical pin fixation, and immediately thereafter they gain both knee and ankle motion. Consequently, there is much to be said in favor of this treatment when the fracture is of a type that tends to displacement. Fractures of the humerus are often so well adapted to the simplest forms of conservative, closed treatment, without interfering with ambulation, that they usually require less radical measures than the weight bearing bones. For that reason we found less occasion to apply mechanical fixation in these cases than elsewhere. On the other hand, it offers an excellent means of treatment if the fracture is unmanageable; and is especially useful if other injuries complicate the case. The forearm is perhaps the hardest location to treat with mechanical skeletal fixation, and possibly offers the fewest advantages. However, in 2 of our cases, forearm fractures were complicated with dislocation of the head of the radius which had resisted several attempts at reduction in other hospitals (Fig. 5). By means of mechanical fixation, each of these was reduced with anatomical repositioning. No other treatment could have been so successful. The use of Waknitz' apparatus on metacarpals is one of the most beneficial applications of mechanical fixation, as well as being relatively simple. It obtains anatomical

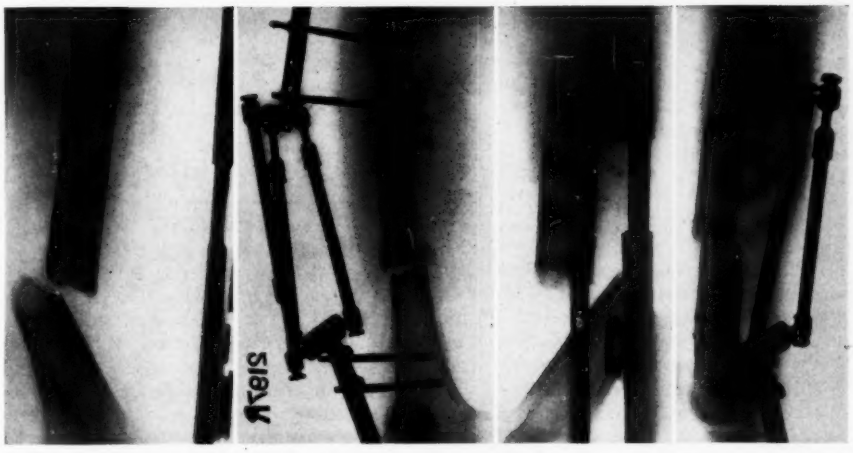


Fig. 7. Correction of a bad backward displacement of a fractured femur by the Haynes apparatus. X-ray shows slight distraction illustrating a preventable error. Callus is forming but was delayed 20 weeks.

reductions, at the same time freeing the hand for a remarkable degree of mobility (Fig. 6). The use of the same apparatus on the jaw offers interesting possibilities, but really lies in a specialty outside the province of this paper. It has already been discussed in the literature by its originators.

ERRORS IN TECHNIQUE

Any new method of treatment should be studied from the standpoint of its harmful possibilities as well as its benefits. In the case of mechanical skeletal fixation it seems certain that it will be subject to certain serious abuses. From our experience, it can be said that such abuses will be due not to the mechanism itself, but to the errors of the surgeons using it. Such errors may spring from ignorance or from incompetence. They may be due to carelessness or impatience, or more especially to the inability of surgeons who are trained in manual manipulation to adapt their outlook to mechanical manipulations. If such errors occur, it is vital that the surgeons should avoid blaming the principles of this treatment for failure due to their own faulty technique. Our own experience has shown that four common dangers are present. (1) It is important to insist upon the most rigid rules of asepsis governing the introduction of the pins; and the nursing staff as well as the surgeons must be strictly supervised. The procedure appears so simple that carelessness may creep in. (2) In applying the pins care must be exercised to see that they penetrate all the way through the opposite cortex. Unless this is done, full stabilization of the fracture cannot be gained; and in addition, the pins may move within the cortex and thereby cause irritation and invite infection. (3) The danger of distracting a fracture must be continually guarded against, for even a slight amount of distraction will surely delay union. This can be prevented by ending the mechanical reduction by a forced impaction, even though the maneuver may lose some of the anatomical perfection of the reduction itself. This should be checked by roentgenogram rather than fluoroscope; and another roentgenogram should be taken in 3 weeks to determine whether any absorption has occurred at the fracture site. If so, a second impaction should be carried out. Figure 7 shows one of the fractures in our series in which a slight amount of distraction was allowed. This roentgenogram shows good callus forming, but it was delayed 20 weeks, and at the time of the patient's transfer to a service hospital was still soft. This was distinctly an avoidable error, though at the time the amount of distraction seemed slight enough to be overlooked. (4) Lastly, in the postoperative care, it sometimes happens that the nursing staff or internes become overzealous in the matter of applying dressings over the pin wounds. There is frequently a small amount of discharge at these sites, and it is important that the dressings should not be applied in a manner to interfere with or obstruct its outlet. As a matter of fact, daily dressings are unnecessary and probably dangerous. Anderson has suggested that the original dressings should

not be disturbed at all. It may prove advantageous, as Walters suggests, instead of using any dressings, to apply a light plaster casing around the limb in order to support the soft tissue. The protection and stabilization of the soft tissue is a major factor in eliminating the superficial discharge we have seen so often where muscles and skin pull against the pins.

END-RESULTS

Unfortunately no type of war surgery lends itself to accurate reports of end-results; and least of all, the results of fracture treatment. From the shortness of our observation, and from the transfer of patients and other interruptions in the observation period, we are unable to present any accurate picture of our findings: and feel that it would be presumptuous to do so. The final test of mechanical fixation will have to come from a larger series of cases than ours, and from more controlled conditions. We can, however, say that our impression is so completely favorable that a more widespread use of the method, under proper supervision, can be enthusiastically recommended. Although too limited to be authoritative, our cases tend to show that this method can be safely used in the presence of infection. Table IV illustrates that none of our clean cases became infected from the use of pins; and that of all cases where infection was already present, only one formed a sinus in the pin tract. This sinus was not serious and healed of itself within 3 months, but must be reported as an unfavorable complication. The one case in which our own error delayed union for 20 weeks has already been noted. On the whole, however, union was speeded rather than delayed by the use of mechanical fixation. No instances of nonunion were produced.

CONCLUSIONS

1. Mechanical pin fixation offers very definite advantage in war surgery.
2. It has special value in treatment of: (a) infected fractures which tend to displacement; (b) fractures complicated by severe shock; (c) fractures with long-standing debilitation from prolonged bed rest.
3. Under certain conditions, mechanical pin fixation may be recommended as a routine treatment for femoral fractures.
4. Possible errors and dangers in the use of mechanical fixation must be studied with care.
5. The results of this series of cases, so far as we have been able to observe them, justify more extensive use of mechanical skeletal fixation.

REFERENCES

1. Anderson, Roger. J. Bone Surg., 1934, 16: 379–393.
2. Idem. Surg. Gyn. Obst., 1936, 62: 865–873.
3. Ibid. 1937, 64: 919–929.
4. Idem. South. Surgeon, 1939, 8: 159–172.
5. Bradford, C. H. Proc. R. Soc. Med., 1941, 34: 786–791.
6. Haynes, H. H. South. M. J., 1939, 32: 720.
7. Lambotte, Albin. Chirurgie operatoire des fractures. Paris: Masson et cie, 1913.
8. Waknitz, F. W., and Converse, J. M. J. Bone Surg., 1942, 24: 154–159.

THE MECHANISM OF LABOR FOR TRANSVERSE POSITIONS OF THE VERTEX

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THE position of the fetal head at the pelvic brim and in the midpelvis, and the movements of engagement and descent and of internal rotation in the mechanism of labor, have produced considerable controversy during the past 200 years. The concept of the *normal* mechanism of labor almost universally accepted since the time of Baudelocque and Naegele, has been set forth in most obstetrical textbooks as occurring in the oblique diameters of the pelvic inlet. Physical science and technology of the 20th century have provided an excellent medium through the roentgen ray for visual perception of the labor mechanism *in vivo*. An important point has already been observed, namely, that the transverse positions of the fetal head (LOT and ROT) are most frequent, not only at the brim but also in midpelvis. Therefore, the mechanism of labor for these positions should be provided for.

Many methods have been developed by radiologists and obstetricians for roentgenographic study of the obstetrical patient. In our opinion, a complete examination should take into consideration the following points in approximate order of importance: (1) mechanism of labor, including position, lever action, internal rotation by visual perception in the stereoscope; (2) pelvic architecture by visual perception in the stereoscope, and by comparison of various diameters; (3) cephalopelvic size relationship visually in the stereoscope; (4) pelvimetry—stereoscopic and with isometric scales on frontal and lateral films; (5) cephalometry.

A high degree of attainment of this complete examination has been obtained with a *combined* radiographic technique which has been used since 1938. This consists of two frontal films of the inlet which are viewed in the stereoscope, as described by Caldwell, Moloy, and D'Esopo, and an isometric lateral film similar to that described by Thoms.

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This study has been conducted under a grant from the Bostwick Fund created by Mr. and Mrs. Dunbar Bostwick and friends.

It has been of interest to learn that Hodges and Dipple (1940) recommended a similar approach as shown by the following statement:

"A reasonable simple and accurate procedure would be the following: (1) sagittal plane diameters measured from a single lateral roentgenogram by means of an isometric scale . . . ; (2) other pelvic diameters and fetal skull and skeleton studied in stereoscopic frontal films . . . Quantitative workup of these stereoscopic films accomplished by (a) plane geometric construction, or (b) by means of the stereoroentgenometer."

A preliminary report of the present study containing a small number of cases was made by Steele, Wing, and McLane in 1938, and consisted of data based on stereoscopic films. This represented experience over a 4 year period. Since that time, the *combined* stereoscopic and isometric lateral technique here referred to has been employed for another 4 year period and forms the basis for the present report. However, experience with the combined technique has shown the need for certain modifications which have been instituted as of January, 1942. A detailed description of the revised method of roentgenographic study has been published elsewhere by Steele and Javert.

PRESENT STUDY

The present study comprises 1,300 patients at or near term, or in labor up to the completion of the first stage, and some postpartum patients. Elimination of positions other than the occiput and of the postpartum patients leaves 1,040 cases which form the basis for the present study. These cases have been divided into two groups: Group I—763 cases with occiput above or at the brim; Group II—277 cases with occiput in the midpelvis, either at, just above, or below the spines.

The incidence for the various positions in both groups are presented in Table I and Figures 1 and 2. In either group, the transverse positions account for 63.4 per cent and 62.8 per cent, respectively, confirming the results of Caldwell, Moloy and D'Esopo. As the head enters the midpelvis, the incidence of left occiput transverse (LOT) positions decreases, as does that for left occiput anterior (LOA); and right occiput transverse (ROT) and

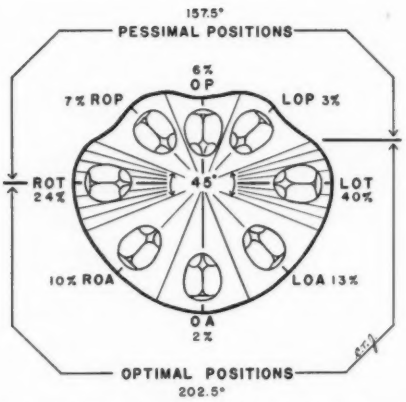

Fig. 1. Incidence of various positions of the occiput at or above the pelvic brim—763 cases. Compare with Figure 2. The various positions are limited to an arc of 45 degrees instead of an arc of 90 degrees formerly employed for oblique positions. Posterior positions are regarded as *pessimal;* anterior, as *optimal.*

right occiput posterior (ROP) positions increase, while right occiput anterior (ROA) decrease. This change is probably due to the effect of dextrorotation of the uterus and may be one of the factors which cause the head to engage. Dextrorotation may also affect internal rotation, favoring left sided positions and opposing right sided positions as suggested by Figure 2 and the increased operative incidence for right sided positions.

The anterior and posterior oblique positions were observed with less frequency than is the pres-

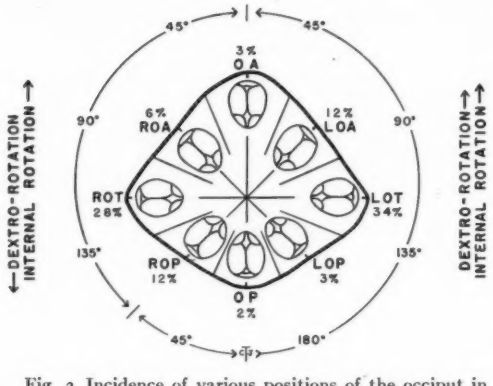

Fig. 2. Incidence of various positions of the occiput in the midpelvis—277 cases. Seen from below. . Note how dextrorotation of the uterus affects the incidence of the various positions as descent occurs. Compare with Figure 1. Internal rotation is favored in left sided positions and is opposed in right sided positions.

TABLE I.—INCIDENCE FOR THE VARIOUS POSITIONS AT THE BRIM AND IN THE MIDPELVIS

	LOT	ROT	LOA	ROA	OA	ROP	LOP	OP	Total cases
Group I*	39.9	23.5	13.2	9.6	1.8	7.3	3.0	.6	761
Transverse	63.4%								
Group II†	33.7	28.8	11.9	5.7	2.8	11.5	3.2	1.8	277
Transverse	62.8%								
Grand total									1040

*Above or at brim.
†At, above or below spines.

ent clinic teaching. For example, in the midpelvis, posterior positions had a total incidence of only 16.5 per cent which is much less than the 27.1 per cent which Danforth obtained in his clinical study of 1,565 private patients.

For the purpose of classifying position; the transverse positions, as well as the anterior and posterior positions, are limited to an arc of 45 degrees (22.5 degrees on either side of the transverse, anteroposterior and oblique diameters) as shown in Figure I. In the past, an arc of 90 degrees has been employed for the oblique positions, and the direct anterior and posterior positions. The direct transverse positions have been ignored because of their supposed rarity.

Posterior parietal presentations occurred more frequently (75.2 per cent) at the brim of the pelvis, and were replaced by anterior parietal presentations as the head approached the spines as shown in Table II. True synclitism, either at the brim or midpelvis, is such a transient occurrence as the head changes from posterior asynclitism to anterior asynclitism, that it was seldom seen, because the exposure of the film could not always coincide with its occurrence. Actually, the majority of cases must experience momentary synclitism. The incidence of anterior parietal presentations in the midpelvis was 76.7 per cent, which confirms the views of Naegele.

TABLE II.—SYNCLITISM AND ASYNCLITISM AT THE BRIM AND MIDPELVIS

	Group I		Group II		Grand total cases
	No.	Per cent	No.	Per cent	
Posterior parietal presentation—posterior asynclitism	361	75.2	30	14.8	
Anterior parietal presentation—anterior asynclitism	86	17.9	155	76.7	
Synclitism	33	6.8	17	8.2	
Total	480		202		682

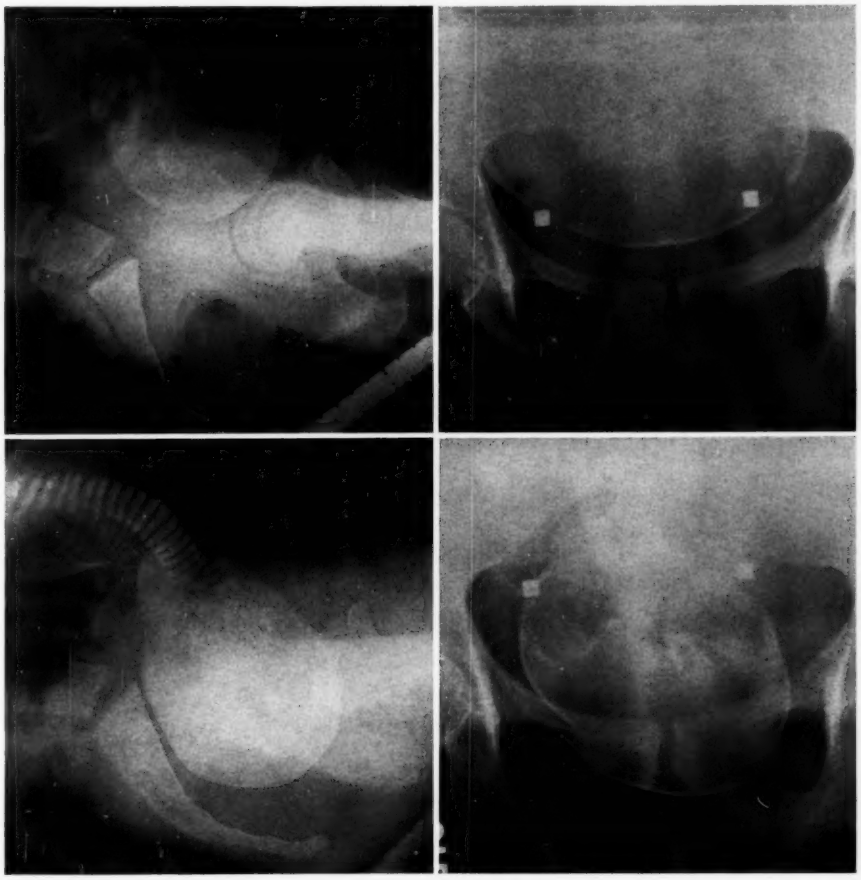

Fig. 3. Frontal and lateral roentgenograms of head in left occiput transverse position at the brim and in the midpelvis. Note flexion of head in frontal films, and lateral flexion backward in the lateral films. Compare with diagrams in Figure 4.

THE MECHANISM OF LABOR FOR TRANSVERSE POSITIONS

The mechanism outlined has been evolved from observations made in the stereoscope and is usually associated with a normal pelvis. It will now be described for the left occiput transverse position (LOT).

At or near term, the head is found before engagement in the transverse position with the posterior parietal presenting over the fore pelvis (Litzmann's obliquity). The sagittal suture is in a horizontal plane above the symphysis pubis and slightly behind it. The relationship of the sagittal suture to the transverse diameter of the superior strait is one of parallelism or a diagonal direction not exceeding 22½ degrees forward or backward as has been shown in Figure 1. Flexion is slight or absent. The fetal spine describes a gentle curve with convexity directed dorsally. Engagement is effected by lever actions which produce lateral flexion of the head backward, accompanied by ventral flexion of the fetal head as shown in Figures 3 and 4. The sagittal suture is now in the transverse diameter of the pelvis or much closer to it (synclitism). Simultaneously, descent begins and soon the posterior parietal presentation at the superior strait is replaced by an anterior parietal presentation in the midpelvis. The sagittal suture of the head has been shifted from a position over the fore pelvis to the region of the midpelvis and

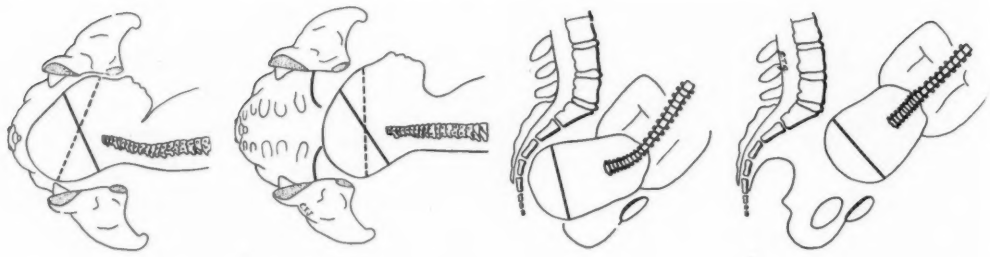

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Fig. 4. Diagrams illustrating lever actions in transverse position. a, Ordinary flexion. Long occipitofrontal diameter is replaced by the shorter suboccipitobregmatic diameter. b, Diagram showing lateral flexion backward. Posterior parietal presentation favors engagement of the biparietal diameter after which the anterior parietal presents. Compare these diagrams with the roentgenograms presented in Figure 3.

posterior pelvis. The lateral surface of the posterior parietal is now found to be nearly parallel to the anterior surface of the sacrum. Further descent toward the sacrococcygeal platform occurs along a line which runs downward and backward and nearly parallel to the anterior sacral surface.

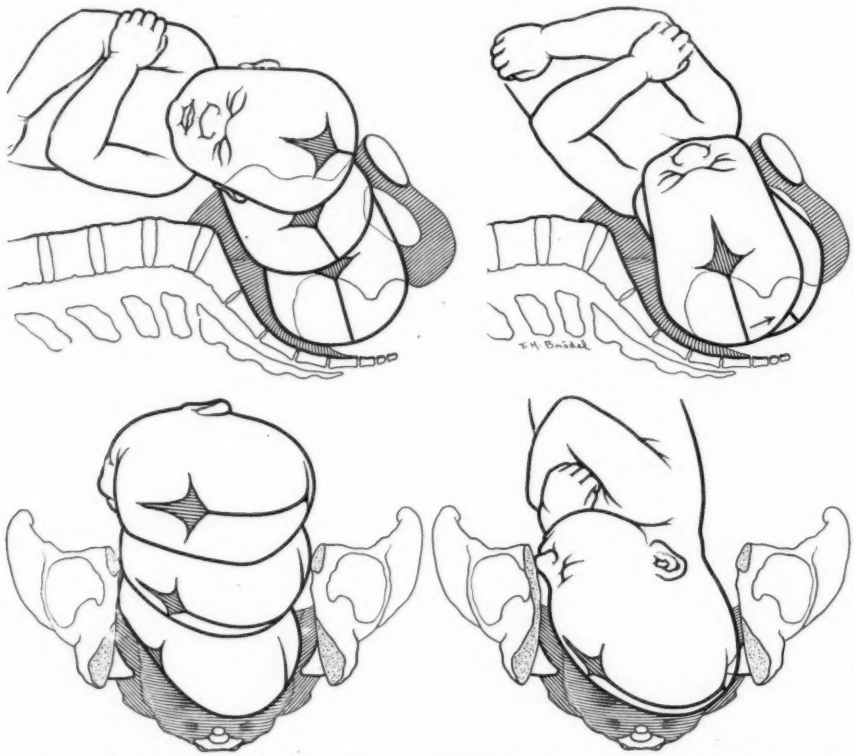

Fig. 5. The mechanism of labor for left occiput transverse position. Posterior parietal presentation at the brim (Litzmann's obliquity). Lever actions produce lateral flexion of the head backward, and flexion of the head on the chest. Anterior parietal presentation obtains after engagement. Lateral flexion forward places the posterior parietal against the left ischial spine and the occipitoparietal eminence against the left ischiopubic ramus.

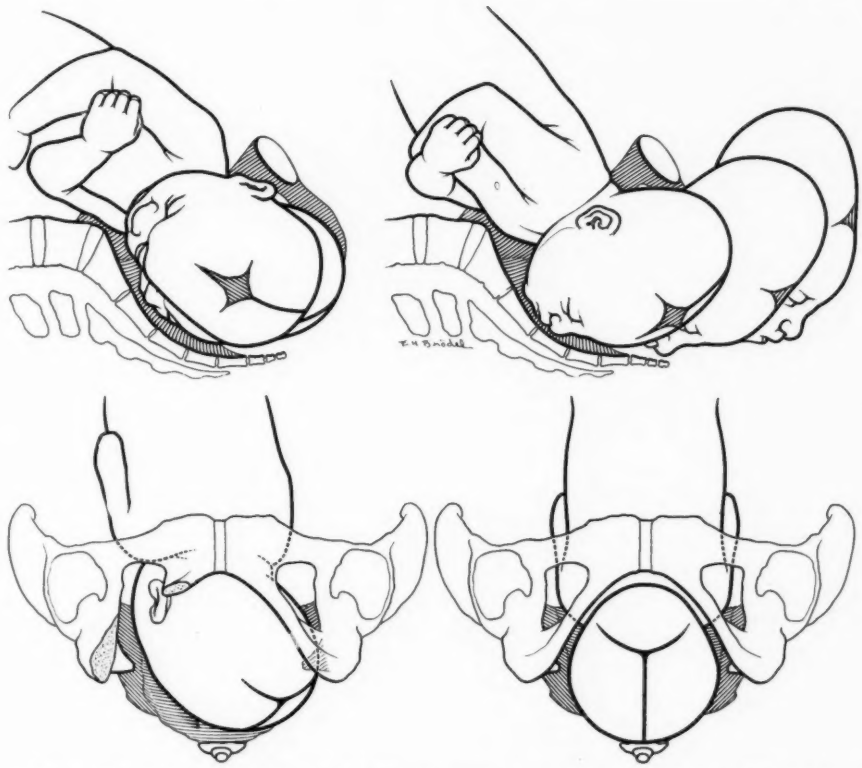

Fig. 6. The mechanism of labor for left occiput transverse position. The occipitoparietal eminence traverses the inner curve of the ischiopubic ramus through an arc of 90 degrees producing internal rotation. The occiput is brought under the symphysis. Extension and expulsion follow. (See Figs. 3, 4, 7, 8.)

The head remains in the transverse position just above or at the ischial spines, with the anterior parietal now presenting, until the end of the first stage of labor. The fetal spine at this point may have straightened perceptibly and the flexion of the head has invariably increased (see Figs. 4 and 5). Important lever actions are in motion. For example, the acute ventral flexion of the fetal head on the chest results from the leverage exerted by the eccentric location of the fetal spine in relation to the long axis (occipitofrontal diameters) of the head. Posterior positions favor extension as shown in Figure 9.

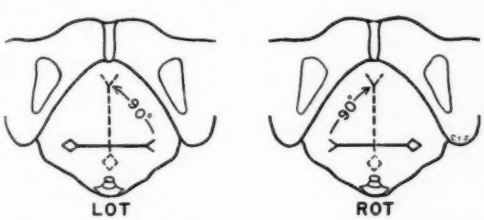

Fig. 7. Internal rotation occurs through an arc of approximately 90 degrees in transverse positions.

At the beginning of the second stage of labor the fetal spine is found to be straight and flexion is acute. The picture is one of rigidity. The vertex assumes a position at or above the spines and continues to move downward and backward to the sacrococcygeal platform. Thereafter, lateral flexion forward occurs, and it precedes internal rotation. This movement in the mechanism has been checked repeatedly on vaginal and rectal examination. The left posterior parietal protuberance now impinges on the left ischial spine. The occiput rotates forward along the gentle curvature of the ischiopubic ramus (inclined plane

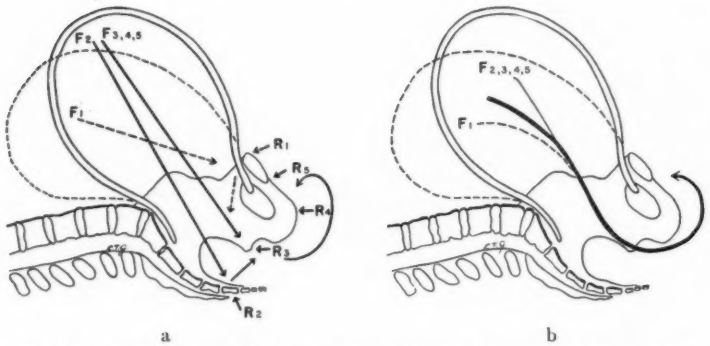

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Fig. 8. a, Parallelogram of forces and the mechanism of labor. b, The resultant force produces a Figure 6 curve. F_1F_5, directions of uterine force during the first and second stages of labor; R_1R_5, resistance forces producing resultants which accomplish engagement, descent and internal rotation.

of Hodges), and internal rotation is produced through an arc of 90 degrees, as shown in Figures 6 and 7. Further descent occurs simultaneously during the rotation, the head remaining acutely flexed. Finally, extension of the occiput usually begins at a low level (below the spines) and is followed by the movement of expulsion.

The above description can be modified to apply to the right occiput transverse position (ROT).

FURTHER OBSERVATIONS

The mechanism aforementioned is the same in all important essentials as that outlined by Pinard and Varnier in 1892. Their observations were made on frozen sections of women dying in various stages of labor. It has been striking and gratifying to confirm observations made on anatomical material 50 years ago by means of a roentgenographic method of study which permits observation of the actual physiological process of labor *in vivo*.

The movement of posterior lateral flexion effecting engagement results from the force exerted by uterine contractions or by intra-abdominal pressure and gravity being exerted in a downward and forward direction, plus the resistance offered by the anterior position of the lower uterine segment, the bladder, and the symphysis. Thereafter, the uterine drive causes the head to descend readily downward and backward. Lateral flexion forward is the resultant of the uterine drive forcing the rounded parietal protuberance against the shelving surface of the lower sacrum. Internal rotation follows impingement of the parietal protuberance on the ischial spine, with the resultant following the inside curvature of the pubic ramus in an upward direction to the pubis. Extension is the resultant of the downward force of the uterine drive and abdominal muscles plus the upward and forward force exerted by the resistant pelvic floor as the occiput stems under the pubic arch. These movements are associated with a constant change

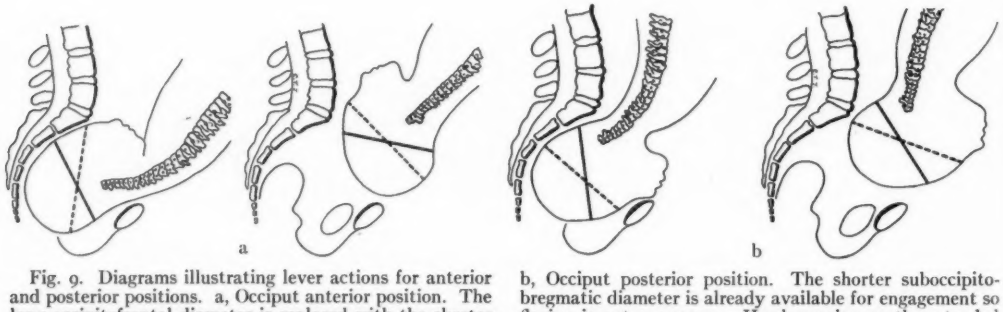

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Fig. 9. Diagrams illustrating lever actions for anterior and posterior positions. a, Occiput anterior position. The long occipitofrontal diameter is replaced with the shorter suboccipitobregmatic diameter and flexion becomes acute. b, Occiput posterior position. The shorter suboccipitobregmatic diameter is already available for engagement so flexion is not necessary. Head remains partly extended until expulsion or internal rotation produces.

in direction and exemplify the parallelogram of forces as indicated in Figure 8.

Observations of Caldwell, Moloy, and D'Esopo have been confirmed with one important exception. They refer to lateral flexion forward in midpelvis as a mechanism encountered in the android type of pelves, whereas our study shows that it may be regarded instead as an integral part of the most frequently encountered mechanism of internal rotation.

The lateral flexion of the head forward preceding internal rotation, is effected by the shunting action produced when the rounded vertex strikes the lower curve of the sacrum and fails to occur when the sacrum is long and straight, and the lateral bore of the pelvis is divergent. It is often under such circumstances that the head becomes arrested in the posterior pelvis—"transverse arrest." This exception tends to prove the rule with regard to lateral flexion forward in the midpelvis.

In view of the fact that the mechanism of labor here described is encountered in the majority of cases and is most frequently associated with a normal pattern of activity plus a spontaneous outcome, it should be included in the normal mechanism of labor. Heretofore, it has been considered pathological as the mechanism for flat pelves by Farabeuf, Williams, and others. As has been shown historically elsewhere, many authorities recognized the transverse position *per se* prior to engagement but they preferred engagement in the oblique because of the sacral promontory. This objection no longer holds since the actual obstetrical conjugate lies in the plane of the ileopectineal lines as pointed out by Caldwell and Moloy and the point of intersection lies below the promontory in the majority of cases.

The mechanism of labor for direct occiput anterior position is *most optimal*, since internal rotation is not necessary, and normal flexion of the fetal head readily occurs because of normal lever action as shown in Figure 9. Conversely, direct occiput posterior positions are regarded as the least optimal, and therefore, *most pessimal*, because internal rotation must occur through an arc of 180 degrees, while lever actions promote extension of the head as shown in Figure 9.

The transverse position has good lever action, and internal rotation through an arc of only 90 degrees is required. For obliquely anterior positions this rotation is reduced to 45 degrees, but for obliquely posterior positions, it is increased to 135 degrees (see Fig. 2). This figure also indicates that the movement of internal rotation is enhanced by dextrorotation of the uterus in left

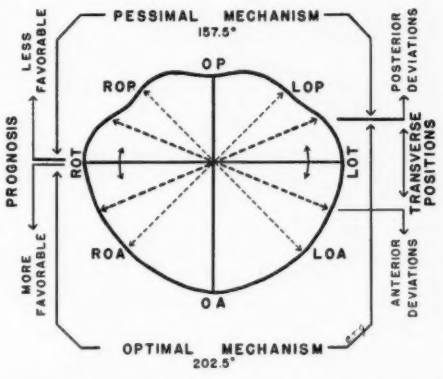

Fig. 10. Diagram showing how position and dextrorotation produces *optimal* and *pessimal* mechanisms of labor. Correct diagnosis of position is vital with regard to prognosis.

sided positions and hindered in right sided positions.

Analysis of the transverse position provides a satisfactory approach to the very complex problem of the mechanism of labor with its numerous interrelated factors and constantly shifting values. The high incidence of left occiput transverse and right occiput transverse positions (63 per cent) justifies this point of view. Variations from the transverse can then be designated as *anterior and posterior deviations* as shown in Figure 10. The transverse and anterior positions are normal and favorable and are therefore regarded as *optimal*. The posterior positions are less favorable as demonstrated by clinical experience, and are therefore *pessimal*. Prognosis can be ventured after evaluation of the various mechanical and dynamic factors.

At term, or in early labor, roentgen-ray images of the fetal skeleton reveal a spine with a gentle dorsal curvature. The head is in a neutral position, or very slightly flexed, with the posterior parietal usually presenting over the forepelvis, as shown in Figures 5 and 6. This picture is observed in the stereoscope on frontal films taken with the mother in a supine position. The lateral film, taken at the same time, but with the patient in an erect position, shows the fetal head to be wholly or partly engaged. A favorable cephalopelvic size relationship is a necessary requirement. It has always been striking that engagement could be accomplished with such ease. Having observed this occurrence hundreds of times, it has been concluded that dextrorotation of the uterus and an increase in muscular tension influence position

and engagement of the occiput, as shown by simply changing the maternal position. Clinical evaluation of disproportion can be carried out to advantage when the patient stands erect.

It is readily appreciated how left sided positions of the occiput can be brought forward more readily than right sided positions. Therefore, the incidence of position at the brim and the midpelvis are different, due perhaps to the forces causing engagement. As shown in Figures 1 and 2, the incidences of right sided positions increase and left sided positions decrease, as engagement occurs, and it is thought that dextrorotation is a responsible factor.

When cephalopelvic size relationship is less favorable, pelvic architecture becomes an important factor in determining position and may interfere with engagement. However, many posterior positions occur when the pelvis is adequate, and in these, dextrorotation is perhaps an influencing factor. An appreciable percentage of posterior positions could probably be corrected with advantage early in labor.

Students and internes working with these concepts for the first time have found them to be of great value in their appreciation of the mechanisms of labor for the various positions.

SUMMARY

A roentgenographic study of 1,300 patients has been reported. A *combined* technique using an isometric lateral film and frontal stereoscopic films was employed.

It was soon apparent that this method of study provided a satisfactory means for classification of pelvic architecture and for visual perception of cephalopelvic size relationship. It also permitted study of the various positions at the brim and those in the midpelvis. The latter could be confirmed by rectal or vaginal examinations. Lever actions, and the mechanism of labor, which are usually ignored by those employing other methods of roentgenography, could be evaluated as well as pelvimetry and cephalometry.

Positions in the transverse, oblique, and anteroposterior diameters of the pelvic inlet were limited to 45 degrees on either side of the diameter concerned, in contradistinction to 90 degrees employed by authorities in the past. Engagement of the occiput in the transverse diameter occurred in 63 per cent of the cases, while the remaining percentage engaged in the anteroposterior or the oblique diameters. The latter were regarded as *anterior and posterior deviations* from the transverse position.

A mechanism of labor for the transverse position based on visual perception in the stereoscope was evolved. It consists of the following movements: Transverse position and posterior asynclitism at the superior strait, lateral flexion backward, ordinary flexion, engagement and descent in the transverse diameter, anterior asynclitism in the midpelvis, lateral flexion forward, internal rotation, further descent, disengagement, extension and expulsion. This physiological evidence obtained *in vivo* by the roentgenogram received pathological confirmation from earlier investigators who studied frozen sections of cadavers.

Anterior and transverse engagements of the occiput result in normal and favorable labor mechanisms and are regarded as *optimal*, whereas posterior positions are *pessimal* for stated reasons involving lever actions and internal rotation. Dextrorotation of the uterus may facilitate internal rotation of the left sided positions and hinder rotation of right sided positions.

REFERENCES

1. Caldwell, W. E., Moloy, H. C., and D'Esopo, D. A. Am. J. Obst., 1934, 28: 824.
2. Danforth, W. C. Am. J. Obst., 1934, 28: 756.
3. Farabeuf and Varnier. Principes fondamentaux d'obstetrique. Paris: G. Steinheil, 1891.
4. Hodges, H. L. The Principles and Practice of Obstetrics. Philadelphia: Blanchard & Lea, 1864.
5. Hodges, P. C., and Dippel, A. L. Surg. Gyn. Obst., 1940, 70: 421.
6. Litzmann, C. Arch. Gyn., 1871, 2: 433.
7. Naegele, F. C. Ueber den Mechanismus der Geburt. Meckel's Arch. Physiol., 1819.
8. Pinard, A., and Varnier, H. Etudes d'anatomie obstetricale, normale et pathologicue (Atlas and Text). Paris, 1892.
9. Steele, K. B., et al. Am. J. Obst. 1938, 35: 938.
10. Steele, K. B. and Javert, C. T. Am. J. Obst., 1942, 43: 600.
11. Thoms, T., and Wilson, H. M. Yale J. Biol., 1937, 9: 305.
12. Williams, J. W. Obstetrics. 6th ed. New York: Appleton-Century, 1931.

ASEPTIC GASTROINTESTINAL ANASTOMOSIS

A One Clamp Method of Universal Application

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THAT the problem of an ideal method of gastrointestinal anastomosis is unsolved is indicated by the succession of articles upon the subject describing new or modified instruments and techniques. At the outset we must admit that an absolutely aseptic technique is probably unattainable. Ligatures and clamps that crush the unopened bowel often force bacteria from the lumen through the intestinal wall, as shown by cultures made from the clamp or ligature used. Intestinal sutures may be contaminated by introduction to the submucosa (4) or even superficially when lymphoid follicles lie close to the serous coat. A bowel greatly distended from obstruction may have walls so thin as to perforate on introduction of even fine sutures. Nevertheless, we clamp and ligate the base of the appendix many times, and, although the laboratory often finds bacterial contamination through the appendiceal wall, the incidence of postoperative infection is no greater than after a similar number of clean abdominal sections in which the appendix or intestine is not crushed. If a purse-string suture is used in the cecum there is a small rise in wound infections but rarely with peritonitis. By a preliminary decompression of distended colon, the bowel thickens so that it may be sutured without perforation. By aseptic gastrointestinal anastomosis, therefore, we would refer to a practical or clinical asepsis associated with such slight bacterial contamination as to be insufficient to cause serious peritonitis or markedly to increase the incidence of suppuration in the abdominal wound. In contrast are the open and semiaseptic methods of anastomosis, procedures which may be done for peptic ulcer with such a low per cent of postoperative infection that aseptic methods, unless they provide at least as good technical results, are not so competitive. In conditions in which the hydrochloric acid in the stomach is low or absent, as with cancer, purulent and necrotic complications, obstruction with retained and contaminated contents and in operations upon the lower bowel an aseptic technique offers the possibility of marked reduction in mortality. Semiaseptic methods of anastomosis, as the method of Doyen (1897), that of Halsted (1891), of Gatch (1912), the knitting needle procedure of V. Pleth (1906), the de Petz stapler, and the pin and clamp method of Furniss (1934), while having advantages over the open method have an added risk.

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An aseptic method should give good technical results. On this basis I would discard the various "bulkhead" methods introduced by Doyen and developed by the Halsted school and others. In the bulkhead method the divided ends of the bowel are closed by ligature and united end-to-end by suture, and then the double bulkhead is opened by dividing or withdrawing the ligatures or by cutting through the bulkhead. This method leaves inverted folds or partial diaphragms which may cause obstructive symptoms, is limited largely to an end-to-end type of anastomosis of the intestine and is inferior to methods of anastomosis by suturing over clamps.

Suture of the bowel ends or sides over straight crushing clamps, which prevent leakage and facilitate suturing, was introduced by O'Hara in 1900 after he had noted the defects of the circular clamp introduced by his chief, Laplace. The O'Hara clamps had the advantage of narrow calibrated blades with one flat side, tongue, and grooved crushing surfaces, and pin fittings so that the two forceps, each holding an end or side of intestine, could be apposed and held in alinement by an additional small clamp. With these forceps end-to-end, end-to-side, or side-to-side, anastomosis was feasible. The O'Hara forceps, adequate for the suture of dog's intestine, with which he largely experimented, had blades too light and narrow to hold securely the thicker human bowel; and a number of larger forceps incorporating O'Hara's principles have since been devised. By using narrow blades which, however, are rather insecure, the amount of bowel inverted in the anastomosis is reduced. To prevent the tendency of the viscus to slip from the narrow blades it may be crushed previously or simultaneously (Rostowzew, 1906), or uncrushed edges may be left projecting beyond the forceps, while the tips may be held in apposition by ferrules or other devices.

Rostowzew, using in part the O'Hara plan, devised heavy crushing clamps holding slender clamp blades in the jaws (1907), while Parker and Kerr in 1908 used clamps for the introduction of

temporary basting stitches which inverted and held the ends of the bowel closed until definitive anastomosing sutures were in place. This additional step is of advantage when the clamp does not hold the bowel securely or does not permit desired mobility.

Moszkowicz (10) in 1908, following Rostowzew, also devised mobile clamps by eliminating the handles and used added devices (pliers and ferrules) to compress and to lock the blades together, changes which later were improved upon by deMartel, Cope, Stone (21), and others. In 1909 Moszkowicz (11) combined in one the two clamps previously used, devising a three bladed clamp with three handles, which was greatly improved and popularized by Rankin in 1928 by incorporating the excellent mechanical principles of the two-bladed Payr clamp. The tongue and grooved blades, to which multiplied levers carry great increase of any force applied to the handles, give the Payr type of clamp a security in crushing and holding thick intestinal or gastric wall not possessed by other clamps with cross-hatched blades or less leverage.

The object of this paper, however, is not to introduce a new clamp for gastrointestinal anastomosis, but to demonstrate what apparently has been largely overlooked: that nearly any type of anastomosis for which clamps are used can be done rather better, aseptically and with but a single clamp. A single clamp with blades broad enough to hold well, as a rule will have less metal to sew over than two narrow, less secure clamps or a three bladed clamp. Less bowel or stomach, therefore, may be turned in to form an objectionable partial diaphragm and constrict the lumen when a single clamp is used. A single clamp is simpler to apply and to disengage, and with less manipulation there may be less contamination. With a single bladed clamp, a partial or complete gastrectomy, a partial esophagectomy or gastroesophagectomy, an anterior or posterior gastroenterostomy, an end-to-end, side-to-side, end-to-side or partial oblique enterectomy may be done. For most purposes I consider the small Payr clamps superior, but an Ochsner or Kocher hemostat, a Martzloff-Bürget-Wangensteen clamp, the Stone clamp, the deMartel-Cope clamp, or other similar instrument may be used. For convenient work in the depths of the abdomen, clamps without handles are desirable. With a number of such clamps of different lengths, complicated and multiple resections of the stomach and intestine may be carried out without soiling. Clamps render apparatus for mechanical semiaseptic suturing quite unnecessary.

There are in the literature a number of references to the use of single clamps for anastomosis. Rostowzew used the slender blades previously mentioned held in the jaws of his powerful crushing enterotribe, and interrupted sutures. Perret considered a single clamp applicable only "when the intestine was small and the wall thin and transparent." He inserted and tied the sutures before withdrawal of the clamp. When the caliber of the intestine was normal or large, Perret used added "coprostatic" clamps with right angled blades and a row of right angled "invaginators." A single clamp method with the bowel ends reversed in the clamp is described by Ssamarin, and the use of a pile clamp with or without a protective basting stitch, by Brenizer.

The aseptic single clamp methods to be described illustrate adaptions of many procedures long used in intestinal surgery to a single principle for safer and more convenient gastrointestinal resections.

RESECTION AND END-TO-END ANASTOMOSIS OF INTESTINE (FIG. 1)

The loop of intestine to be removed with the attached mesentery is liberated and the arms of the loop at the lines of proposed resection superimposed by four guy sutures (Fig. 1*a*,) or Allis or other visceral forceps to maintain proper alinement. While traction is used to spread the apposed loops two crushing clamps are applied about 5 millimeters apart. Each clamp includes both arms of the intestinal loop in its grasp. The loop of liberated bowel is cut off by cautery between the two clamps (Fig. 1b). The ends of bowel to be anastomosed now remain alined in the grasp of a single clamp. This clamp is turned over and two posterior rows of interrupted or continuous sutures are introduced (Fig. 1c). The clamp then is rotated back to its first position, thus exposing the anterior surface of the bowel and a continuous

Fig. 1. Aseptic intestinal anastomosis with a single clamp. a and a_1, Arms of long or short loops of bowel to be resected superimposed and alined by traction sutures. Broken line indicates line of section. b, Arms of loop doubly clamped, being divided by cautery. c, Residual clamp turned over with insertion of first posterior row of sutures; a second row to follow. d, Clamp turned back, thus exposing anterior face of bowel. Anterior continuous Cushing suture introduced over clamp. e, Clamp opened and withdrawn as anterior continuous suture is tightened. f, Second row of anterior sutures being introduced. G, Double intestinal resection illustrated by removal of a short loop of attached ileum with a section of colon. The loop of ileum is folded together, divided by cautery between obliquely placed clamps and then, with the resected mesentery closed by rows of sutures, h, applied behind and over the clamp as in c, d, e, f.

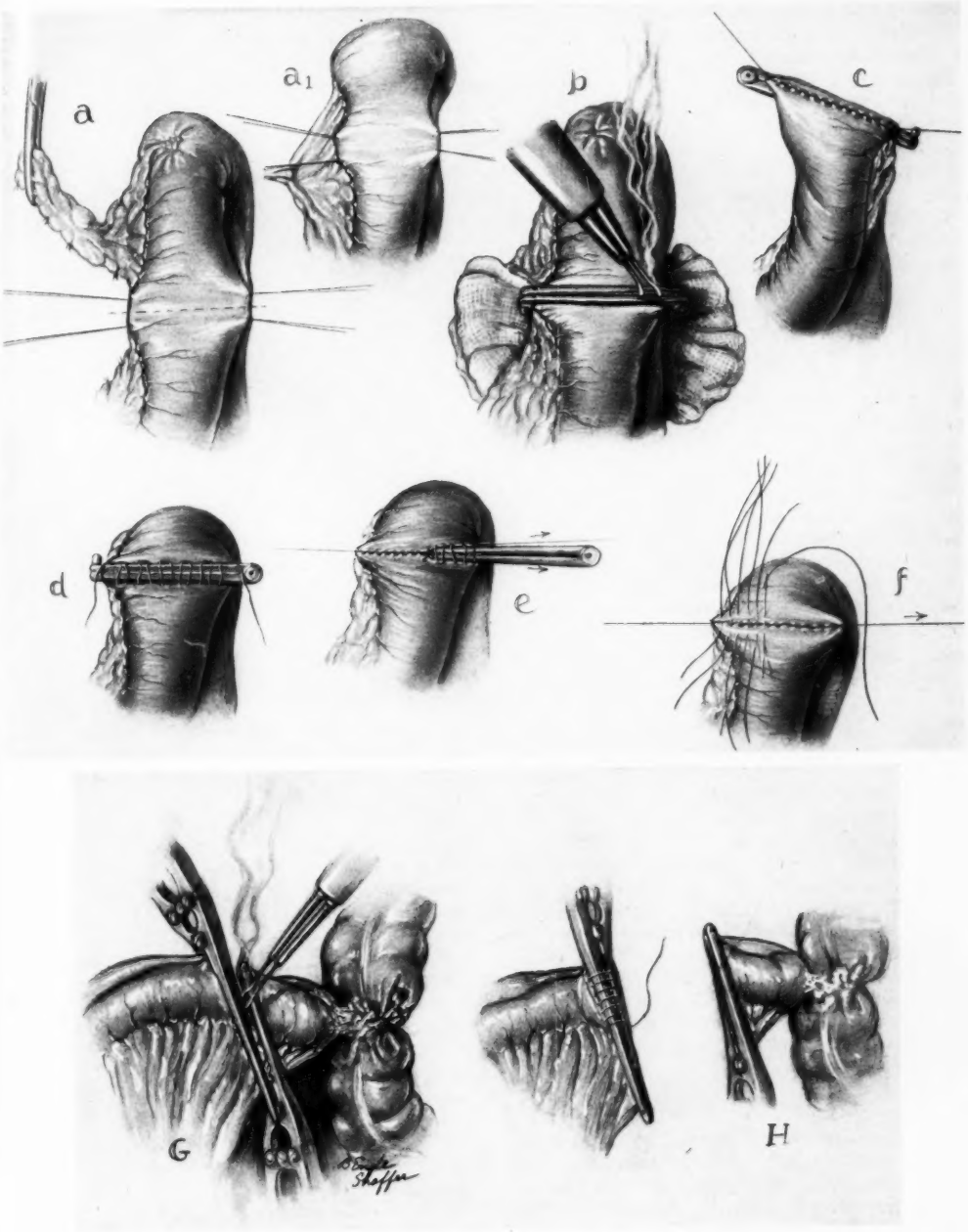

Fig. 1.
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Cushing suture is applied over the clamp (Fig. 1d). While traction is made upon the ends of this anterior continuous suture, the clamp is withdrawn, thus inverting the mucous edges into the lumen of the bowel and completing the closure without leakage (Fig. 1e). The ends of the anterior suture are tied to contiguous ends of the inner posterior suture. One or two additional anterior rows of continuous or interrupted anterior sutures are inserted as required (Fig. 1f). The lumen is established by invaginating the adjacent intestinal wall with the thumb and finger.

The removal of a small segment of bowel which has been traumatized or invaded by inflammatory or malignant process may be carried out very expeditiously by an oblique single clamp method. The affected loop is folded together and the clamp is applied obliquely across the base of the segment of intestine and mesentery to be removed (Fig. 1G). A second clamp is applied a few millimeters distal to the first and the segment is cut off between the clamps with a cautery. The segment to be removed then may remain clamped and attached to the primary malignant or inflammatory area, in connection with which it can be removed later. Traction and approximating sutures or forceps often are unnecessary for this simple operation. After removal of the segment of bowel and omentum, the anastomosis is completed by the introduction of rows of posterior and anterior sutures similar to those described for an end-to-end anastomosis. The anterior inverting suture is carried in advancing loops along the edges of the omentum, thus simultaneously closing the gap and arresting hemorrhage.

This type of resection is a quick and convenient way to deal with gunshot wounds and other injuries of the intestine, fistulous areas as well as localized tuberculous and malignant implantations. The smallest Payr clamp is preferred and is used to crush simultaneously both the bowel and the folded edge of the mesentery. I have resected thus over 30 centimeters of small intestine without an individual ligature in the mesentery. Care should be taken that the mesenteric edges of the bowel are enfolded properly by suture.

ILEOCOLECTOMY WITH END-TO-END ANASTOMOSIS (FIG. 2)

The distal part of the ileum, the cecum, appendix, ascending and, if desired, part of the transverse colon are liberated for removal. By means of four guy sutures or visceral forceps the ileum is spread obliquely over the transverse colon and, while traction is used to aline the superimposed segments of bowel, two clamps are applied about 5 millimeters apart across both colon and ileum (Fig. 2A). The arms of the loop then are divided between the clamps by cautery (Fig. 2C). The clamps should crush the ileum obliquely from the mesentery away from the lesion, the transverse colon transversely, in such fashion that the opening of the ileum will have the same diameter as that of the transverse colon. The ends of the ileum and transverse colon to be united now are apposed in the grasp of a single, preferably a Payr, clamp. The clamp is turned over and the posterior rows of interrupted or continuous sutures are introduced. This may be done before the loop of bowel has been removed, as shown in Figure 2B, or preferably after the division by cautery shown in Figure 2C. The clamp then is reversed, thus exposing the anterior surfaces of the colon and ileum, and a continuous anterior Cushing suture is introduced over the clamp, as shown in Figure 2D. The clamp is removed as this suture is tightened, thus inverting and approximating the anterior edges of intestine, and the ends of the suture are tied to corresponding ends from the first posterior row. One or two additional rows of interrupted or continuous sutures are inserted anteriorly, as shown in Figure 2E. Before any sutures are introduced, all fat and adventitious tissue are dissected carefully from the surfaces to be united and active arterial circulation up to the margins of the clamp is proved. As with all these anastomoses, immediately following the insertion of sutures, the lumen of the bowel is re-established by pressure between the thumb and finger. We consider this method preferable to a side-to-side anastomosis.

SIDE-TO-SIDE INTESTINAL ANASTOMOSIS

The segments of bowel to be united are alined and two rows of posterior sutures are introduced, thus uniting the anterior face of the under segment and the posterior face of that superimposed, below the antimesenteric borders. These posterior sutures also may be introduced after the application of the clamp. The antimesenteric borders of the contiguous loops of bowel, held together by visceral forceps or sutures, are elevated and the two longitudinal folds of bowel thus formed are crushed together by a clamp which should include the mucous lining of each fold. The two folds of bowel projecting above the clamp now are burned off, to form contiguous longitudinal openings in each loop. An anterior continuous Cushing suture is applied over the clamp, which is tightened as the clamp is withdrawn and the ends of the suture are tied to adjacent ends from a posterior suture line. Such additional anterior row or rows of interrupted or continuous

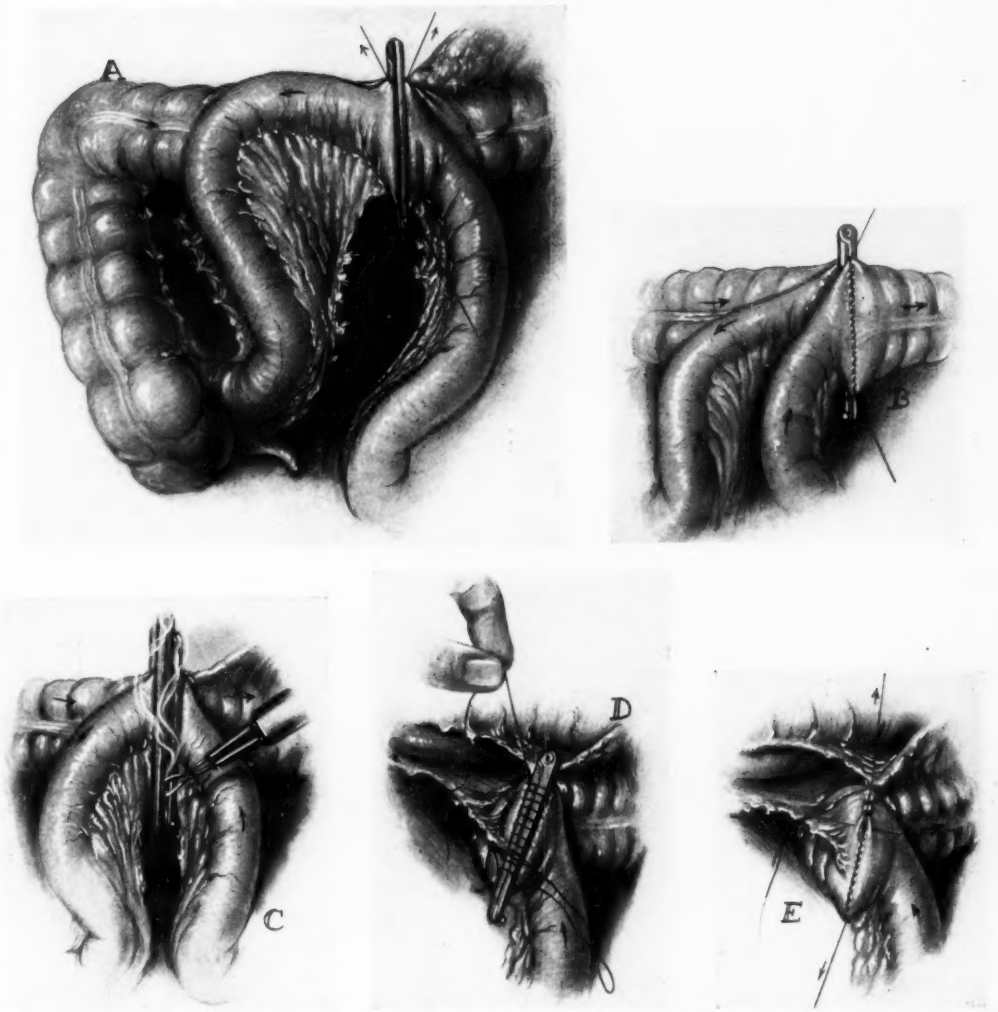


Fig. 2. Ileocolectomy. A, The loop of ileum and colon to be removed has been liberated, and under traction a clamp has been applied obliquely to the ileum, transversely to the underlying colon. On the ileum the clamp inclines proximally to the antimesenteric border. B, The clamp has been rotated and the first row of posterior sutures inserted. A second row follows. C, A protective distal clamp is applied and the loop amputated by cautery. D, The anterior continuous Cushing suture over the clamp inserted. E, With withdrawal of the clamp the Cushing suture has been tightened and an additional anterior row of sutures is being introduced.

sutures as seem desirable are introduced and the opening between the two loops is established by digital manipulation.

END-TO-SIDE ANASTOMOSIS USING A SINGLE CLAMP

For clarity the procedure will be described as an anastomosis between the end of the ileum and the side of the colon. The ileum having been divided by cautery between clamps, the proximal end, closed by one of the clamps, is placed across the colon so that the clamped end approximates the antimesenteric border of the colon. The posterior surface of the ileum is united to the anterior surface of the colon by two rows of sutures run-

ning parallel with the border of the colon. A contiguous fold of the antimesenteric border of the colon is raised by a row of viscera forceps over a length corresponding to the width of the ileum. A clamp is applied to this fold of colon below the viscera forceps, including the clamped end of the ileum. The end of the ileum with its clamp and the projecting fold of colon above the clamp are burned off by cautery. This leaves a side opening of colon and a terminal opening of ileum in juxtaposition. A continuous Cushing suture is applied over the single clamp, which is tightened as the clamp is withdrawn and the ends are tied to appropriate ends of the upper posterior row of sutures. One or two additional rows of sutures are inserted anteriorly between the colon and ileum to reinforce the union.

For multiple resections it is desirable to have a number of small short clamps available to prevent leakage and infection and to aid the later approximation in a single clamp, at which time the provisional occluding clamps are burned off with the intestinal ends. This greatly facilitates complicated forms of anastomosis, as in cases in which multiple sections of bowel or bowel and stomach must be removed. To facilitate these operations I have had made a number of short and long hinged clamps resembling the Stone clamp but having the locking device of the deMartel type. By tapering and streamlining the blades of the clamp it may be removed easily from under the inverting continuous Cushing suture. The Stone closing forceps is not powerful enough to close such a clamp upon the duodenum or even a thick esophagus, but sufficient pressure may be applied to the blades by a Payr clamp or strong pliers. In the introduction, removal, and fixation of the clamp in the depths of the abdomen or thorax, a removable holding device which will not interfere with opening or closing the clamp is desirable, especially during the introduction of sutures (Fig. 7A). In using hinged long gastric clamps additional pressure near the middle of the blades, where they tend to spring apart under strain, may be necessary and is supplied by a yoke with screw pressure (Fig. 7C).

MULTIPLE INTESTINAL RESECTIONS WITH A SINGLE CLAMP

For clarity we will consider that a cancer of the transverse colon has invaded the underlying jejunum. A pair of short clamps are applied to the colon well to the left of the lesion and similarly to the jejunum, and the colon and jejunum are divided between the clamps by cautery. Similar pairs of short clamps are applied to the colon and jejunum, well to the right of the lesion, and the colon and jejunum are separately divided by cautery between these clamps. The diseased attached segments of colon and jejunum are liberated and removed together. This leaves a proximal and distal segment of colon, each end aseptic and protected by a clamp; and a proximal and distal end of jejunum, each end also closed by a clamp. The two jejunal clamps then are apposed, the underlying segments are crushed together by a single clamp, above which the two jejunal ends with their attached clamps are burned off. This leaves the two ends of jejunum superimposed in the grasp of a single clamp, and the anastomosis is completed with rows of posterior and anterior sutures as described for an end-to-end intestinal anastomosis with a single clamp. A similar procedure then is used to unite the proximal and the distal clamped ends of the colon. This method, with the temporary application of multiple short clamps, also is used when it is not feasible at first to liberate a loop of bowel to be excised.

ABDOMINOPERINEAL PROCTOSIGMOIDECTOMY WITH PERINEAL ANUS AND THE FORMATION OF A PELVIC DIAPHRAGM

The segment of rectosigmoid to be removed is liberated with its attached mesentery to the pelvic floor, divided well above and also well below the lesion by cautery between short clamps, and removed. The proximal sigmoid and, if necessary, the adjacent descending colon is sufficiently liberated that the viable end will reach through the pelvic floor, or about 5 inches below the posterior pelvic brim. The proximal and distal clamps each covered with stockinet are laid against the floor of the pelvis. A pelvic diaphragm of liberated peritoneum, including that from the bladder, now is formed around the segment of sigmoid in the pelvis and the abdomen is closed. Through an incision from the posterior border of the anus along the side of the coccyx, the pelvis is entered and the stockinet, attached clamps, and bowel segments are withdrawn. The anal segment, having been thoroughly cleansed previously and packed with antiseptic gauze, is resected and split posteriorly with removal of its clamp and the clamped end of the sigmoid is laid in the anal gutter thus formed. A curved, perforated drain is left in the hollow of the sacrum, sutures introduced, dressings applied, the sigmoid clamp removed, and a rectal tube is tied in the sigmoid. This procedure obviates the difficulty of forming a pelvic diaphragm when a pull-through type of proctosigmoidectomy is done.

Occasionally with a perforated carcinoma and associated abscess, it is possible to avoid soiling by an *en masse* aseptic resection. Mrs. R., a rather obese patient, had developed a large abscess of the left abdominal wall 7 months before admission. This had been drained through a long incision which had healed after 4 months. On admission it was evident that a residual abscess still existed in the fatty abdominal wall. A wide elliptical incision was made about the mass, which was found attached to a large cancer involving the splenic flexure and adjacent transverse and descending colon. A very large loop of colon was liberated with the attached abdominal wall, and the arms of the loop formed

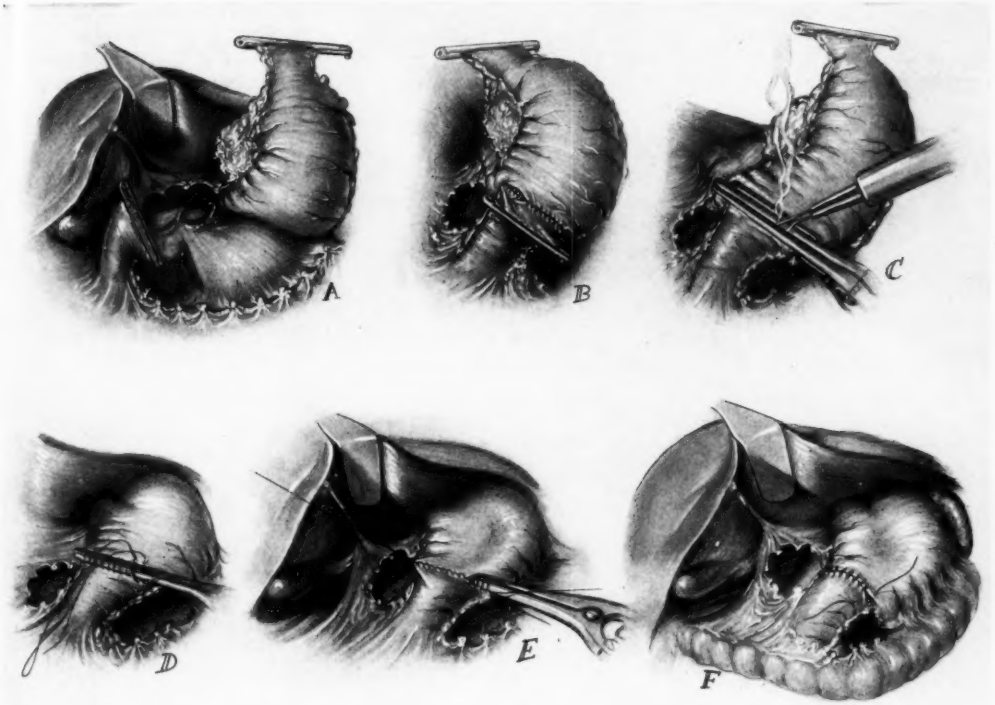


Fig. 3. Billroth I. Partial gastrectomy. A, The part of stomach to be removed has been liberated, the duodenum divided between clamps. B, The duodenum is stretched across the posterior surface of the stomach and the outer row and a part of the inner row of posterior sutures introduced. C, The stomach and attached duodenum are doubly clamped together and divided by cautery distal to the suture lines. Usually, to conserve duodenum, the protective distal clamp is applied to the stomach alone. D, An anterior continuous Cushing suture is being inserted; in part between the anterior surface of the stomach and duodenum, in part between the anterior and posterior surfaces of the stomach. E, The Cushing suture is tightened as the clamp is withdrawn. F, An additional row of inverting anterior sutures is applied between stomach and duodenum, and over projecting ends of stomach.

of the proximal transverse colon and the proximal sigmoid were apposed and divided by cautery between clamps. An end-to-end anastomosis was carried out over the single remaining clamp. A complemental cecostomy was done. The patient recovered without wound abscess.

SUBTOTAL GASTRECTOMY WITH A SINGLE CLAMP

Subtotal gastrectomy with a single clamp may be done after the Billroth I, Reichel-Pólya antecolic, retrocolic, or the Hoffmeister-Finsterer plan.

Billroth I, partial gastrectomy (*Fig. 3*). The portion of stomach to be removed is liberated in the usual manner (Fig. 3A), the duodenum divided between clamps by cautery and the lower part of the stomach turned out of the wound over the left thoracic wall, exposing its posterior surface. The duodenum is mobilized by the Kocher division of the hepatoduodenal ligament. The posterior surface of the clamped duodenum is stretched along the line of proposed anastomosis on the posterior wall of the stomach by two transverse rows of posterior sutures. A narrow Payr or other reliable clamp is applied across the stomach and duodenum above the suture lines and below the duodenal clamp. If the clamp is too short to reach across the stomach a second may be applied from the opposite side. The combined stomach and duodenum now are divided together by cautery between the clamps (Fig. 3C). This removes the end of the duodenum with its clamp. Usually the duodenal clamp is placed between the other two clamps instead of as shown in the figure. The edges of both stomach and duodenum now are approximated in the jaws of a single clamp. The anterior surfaces of the stomach and duodenum

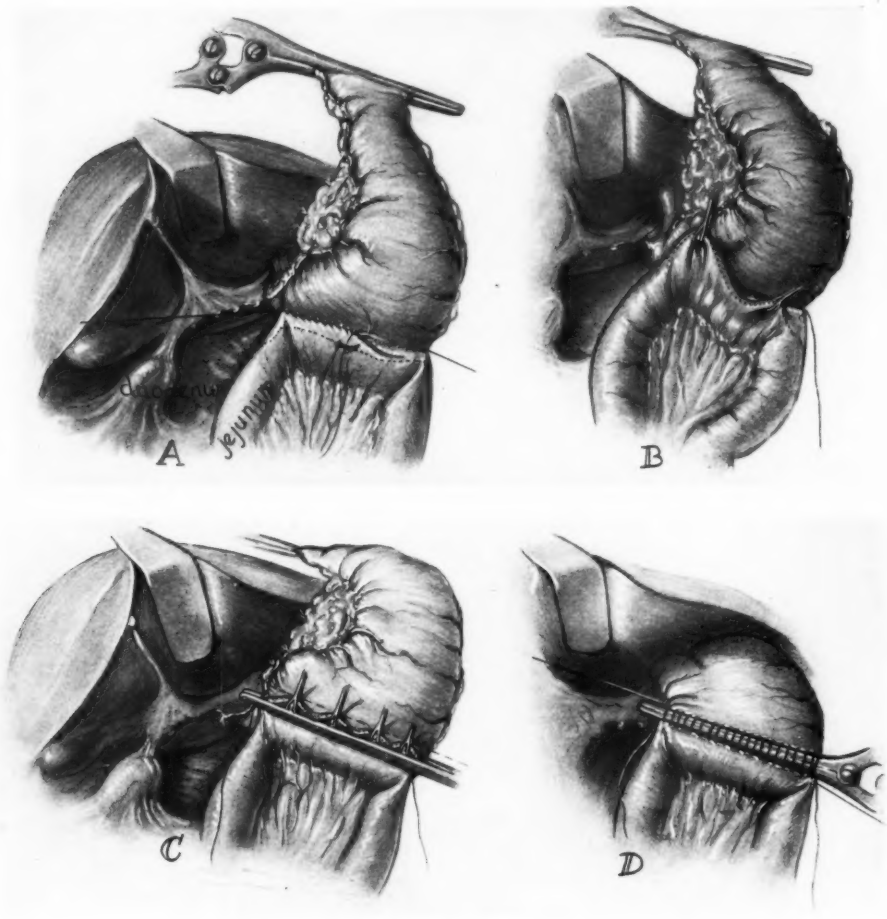


Fig. 4.
(*Legend on opposite page*)

are united over the clamp with a continuous Cushing suture. If the distance is long it may be divided between two continuous Cushing sutures. The suture also unites and inverts the anterior and posterior edges of the stomach except where the stomach is covered by duodenum (Fig. 3D). This continuous suture is tightened as the clamp is withdrawn (Fig. 3E), fixing and inverting the end of the duodenum between the edges of the stomach. The ends of the continuous suture are tied to adjacent ends from the posterior row. An additional one or two rows of interrupted or continuous anterior sutures are introduced, as shown in Figure 3F. The stoma is opened by manipulation.

Reichel-Pólya resection of the stomach with a single clamp (*Fig. 4*). The desired portion of stomach is liberated, the duodenum is divided by cautery between clamps, and the stomach is reflected out of the abdomen. The distal end of the duodenum is closed over the clamp, by means of a continuous Cushing suture which is tightened as the clamp is withdrawn, and the closure is reinforced by one or two rows of additional sutures which further invert the edges. A loop of jejunum about one-half meter below the ligament of Treitz is brought in front of the colon and its posterior surface is fastened across the posterior surface of the stomach with two rows of interrupted or continu-

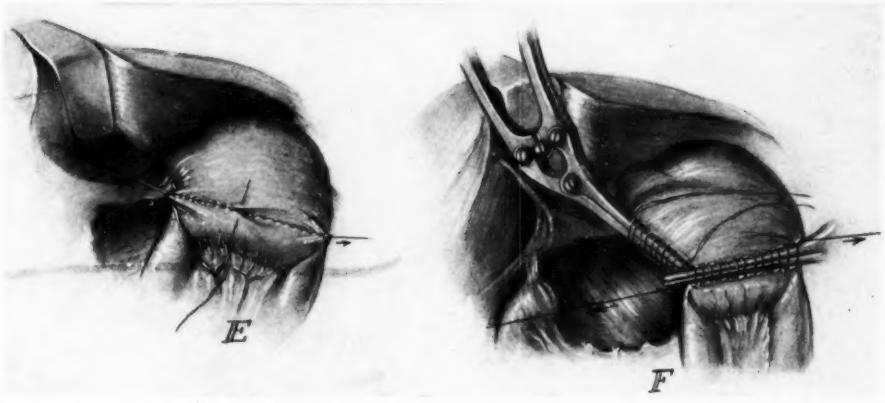


Fig. 4. Antecolic or retrocolic Reichel-Pólya partial gastrectomy. A, The stomach liberated, the duodenum divided between clamps and the lower end of the stomach turned out of the wound. The posterior surface of a loop of jejunum is being united across the posterior surface of the stomach with two rows of sutures. B, An antimesenteric fold of jejunum is raised against the posterior surface of the stomach by forceps or sutures. C, A clamp is applied across the stomach and the antimesenteric fold of jejunum distal to the suture lines. Divided line indicates position of protective clamp. D, The stomach has been divided between clamps and the antimesenteric border of the jejunum burned off by cautery, leaving the open edge of jejunum and end of stomach in the grasp of one clamp. An anterior Cushing suture has been applied over the clamp. E, The anterior continuous suture has been tightened as the clamp was withdrawn, and tied. A second row of reinforcing sutures is being introduced. When there has been a previous gastroenterostomy or gastric resection the two clamped and divided ends of jejunum may be united side-to-side to the end of stomach using a single clamp, after the plan of the Billroth I (Fig. 3), except that a double-barreled end-to-end jejunal juncture is made with the end of the stomach. F, Arrangement of the clamps for a Hoffmeister-Finsterer modification. The stomach has been resected. The posterior sutures between the stomach and jejunum have been placed. An anterior Cushing suture has been inserted over each clamp, each one to be tightened as the clamp is withdrawn. The operation to be completed by an additional row of sutures.

ous sutures (Fig. 4A). A fold of the antimesenteric edge of the jejunum is raised by viscera forceps or sutures across the line of proposed division of the stomach, as shown in Figure 4B. A single clamp is applied across the stomach and the antimesenteric edge of the jejunum below the line of visceral forceps. It is important that the mucous lining of the jejunum projects above this clamp when it is closed (Fig. 4C). A distal protecting clamp is applied across the stomach, and the stomach is divided between the clamps and projecting fold of jejunum burned off by cautery. An anterior continuous Cushing suture is applied over the clamp between the anterior surface of the stomach and the anterior surface of the jejunum (Fig. 4D), and the clamp is withdrawn as this suture is tightened. The ends of this suture are tied to ends of the upper posterior row of sutures and an additional row of anterior interrupted or continuous reinforcing sutures is introduced (Fig. 4E). Obviously a shorter stoma may be formed by including a shorter fold of jejunum in the single clamp, or a double barreled gastrojejunostomy by including a complete loop of jejunum. Figure 4F illustrates the technique for the Hoffmeister-Finsterer partial gastrectomy, using two clamps and two continuous inverting Cushing sutures. In any case a sufficient fold of jejunum should be brought through the clamp to include the mucous lining; otherwise, an open stoma will not be formed.

For a retrocolic anastomosis the loop of jejunum is brought through an opening in the transverse mesocolon and the anastomosis is then made as with the anticolic method. At the completion of the retrocolic anastomosis the stomach along the line of anastomosis is sutured to the edges of the opening in the transverse mesocolon.

GASTROJEJUNOCOLIC RESECTION FOR GASTROJEJUNOCOLIC FISTULA

The colon and jejunum are doubly clamped separately on each side of the fistula and are divided between the clamps by cautery. If the original peptic ulcer has healed it now may be feasible to remove, between clamps by cautery, the segment of stomach containing the stoma, with the attached clamped segments of colon and jejunum.

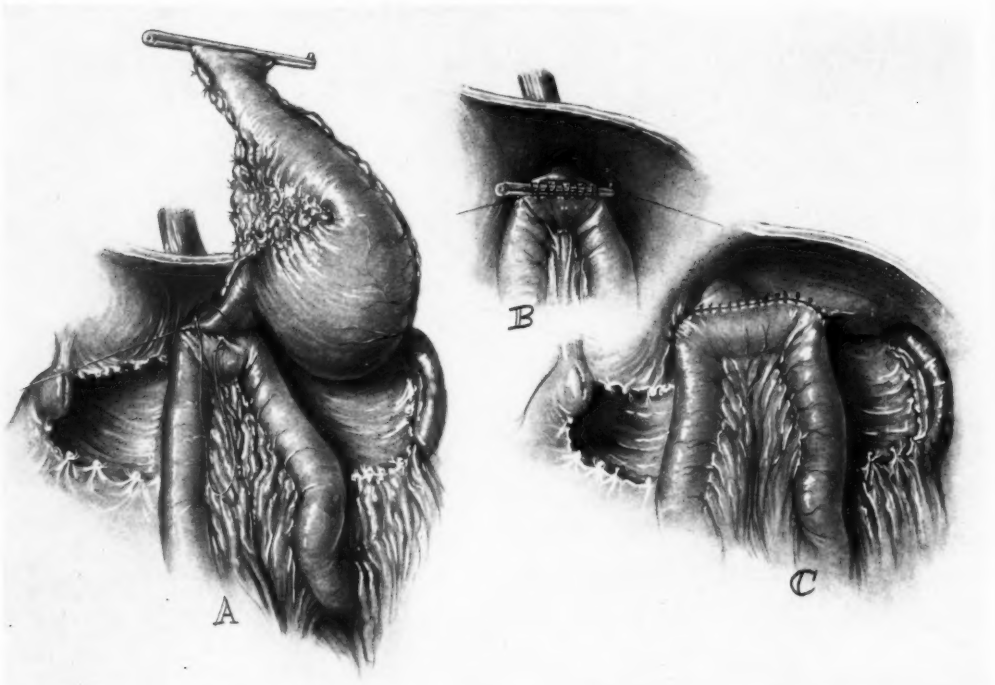


Fig. 5. Total gastrectomy. A, The duodenum is divided between clamps and the distal end closed by suture. The stomach, liberated wide of the lesion, is turned out upon the chest. The esophagus has been partly liberated and withdrawn from the diaphragm. Two rows of sutures are being introduced between the posterior wall of the esophagus and the posterior wall of the loop of jejunum. With completion of the posterior rows of sutures a clamp will be applied across the esophagus and an antimesenteric fold of jejunum (similar to Fig. 4, C, D), and the esophagus divided between clamps and the antimesenteric fold of jejunum burned away by cautery. B, The open end of the esophagus and open side of the jejunum are compressed in the single remaining clamp. A continuous Cushing suture is being applied over the clamp. C, The Cushing suture has been tightened as the clamp was withdrawn and tied, and an additional row of sutures applied to reinforce the sutured edges and to support the arms of the jejunum to the diaphragm. A flap from the under surface of the diaphragm may be added for reinforcement.

The stomach then is closed over the remaining clamp as in terminal closure of the duodenum. The two jejunal clamps are apposed, the ends of jejunum alined and clamped together by a third clamp and the projecting clamped ends of jejunum are burned off by cautery. This leaves in a single clamp the ends of the resected jejunum in position for an aseptic end-to-end anastomosis, which in turn is followed by a similar aseptic end-to-end anastomosis for the resected transverse colon. The gaps in the transverse mesocolon and in the jejunal mesocolon are closed by suture and a complemental appendicostomy or cecostomy is done. In most cases instead of the segmental resection of the stomach described it is better to do a Pólya or Hoffmeister partial gastrectomy. In this case, after liberation of the stomach and division of the colon and jejunum between clamps, the liberated stomach with the attached clamped segments of small and large intestine is turned out of the abdomen. The retained jejunum and colon are united end-to-end over a single clamp as previously described and a lower segment of intact jejunum used for the gastrojejunal anastomosis. If the proximal arm of the existent gastrojejunostomy is long enough, which is not usual after a short-loop posterior gastrojejunostomy, a double barreled end-to-end anastomosis between the two ends of the jejunum and the end of the stomach may be done following the one clamp technique, thus eliminating the jejunal side-to-end anastomosis.

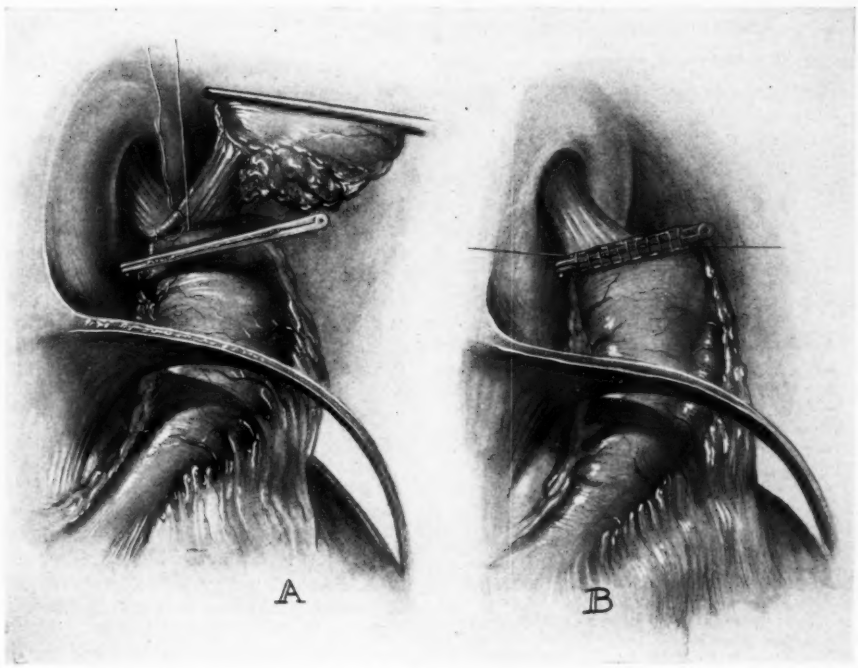
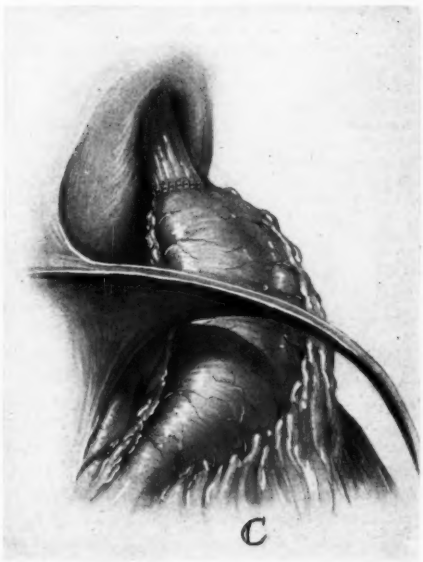


Fig. 6. Transthoracic resection of the cardiac end of stomach and lower esophagus. A, Through a thoracic incision the stomach has been liberated, brought into the chest and divided by cautery between clamps well below the tumor. The posterior surface of the distal end of the stomach is being united to the posterior surface of the esophagus with two rows of sutures. Two clamps are to be applied across both stomach and esophagus anterior to the suture lines and the stomach and esophagus divided by cautery between these clamps. B, This leaves the ends of the stomach and esophagus in the grasp of a single clamp. An anterior Cushing suture has been inserted, which is to be tightened as the clamp is withdrawn. C, Additional reinforcing and supporting sutures are introduced.



In one patient, in whom the fistula was small and running directly from the stomach into the transverse colon, the colon was closed by inverting sutures without resection. The arms of the jejunal loop were liberated through the transverse mesocolon, each arm was divided between clamps and the liberated portion of stomach, with the two clamped arms of jejunum attached, turned out of the wound upon the chest. A single clamp was applied under the two clamps closing the ends of the retained jejunum and the jejunal ends with their clamps were burned off, thus leaving the two aseptic ends of jejunum approximated in the single clamp in position for an end-to-end aseptic anastomosis. After this anastomosis had been completed a more distal segment of the jejunum was used for an antecolic Pólya type of gastric resection. The patient had an uncomplicated convalescence.

En bloc resection of the stomach, transverse colon, superficial layers of the pancreas and associated abscess for per-

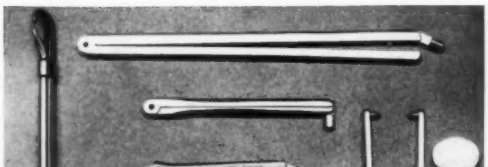


Figure 7. A, Clamp holder to facilitate placement and manipulation of clamps in depths of wound. B, Modifications of deMartel and Stone clamp used for aseptic gastrointestinal anastomosis. C, Compression yoke with removable key occasionally desirable to increase compression of the longer gastric clamps, and especially for lateral resections of stomach when the locking "dog" cannot be used.

forated gastric carcinoma. A woman of 60 years had a fetid abscess about 5 centimeters in diameter surrounded by adherent stomach, pancreas, and transverse colon, due to a 2 centimeter perforation of a large ulcerated carcinoma of the stomach. In separating the fused structures, the abscess was accidentally entered and immediately closed by suture of the omentum and part of the transverse colon to the anterior surface of the stomach. The mass then was mobilized by dividing the transverse colon laterally between clamps, the duodenum between clamps, and by shaving off the outer surface of adherent pancreas. With sufficient division of the gastrohepatic and gastrocolic omenta and adhesions, the mass consisting of stomach, abscess, and clamped section of transverse colon was turned out of the abdomen. An end-to-end single clamp anastomosis of the colon was performed by alining and clamping together the intestinal ends just beneath the two protecting clamps, which were burned off with a cautery. The lower four-fifths of the stomach with attached structures and clamps then was resected by the antecolic Pólya single clamp aseptic method and a complementary cecectomy was done. With the exception of a small incisural abscess which healed in 5 days, the patient had an uninterrupted operative recovery.

TOTAL GASTRECTOMY WITH A SINGLE CLAMP (FIG. 5)

The stomach and terminal esophagus are liberated as wide of the lesion as possible (Fig. 5A). The duodenum is divided by cautery between clamps and the stomach is turned out of the abdomen. The distal end of the duodenum is closed carefully by sutures. Two rows of sutures are inserted between the posterior wall of the esophagus near the line of proposed anastomosis and the posterior wall of a loop of jejunum about one-half meter from the ligament of Treitz. A clamp then is applied across the esophagus and a fold of the antimesenteric border of the jejunum, which has been raised by viscera forceps as in the Pólya single clamp gastrectomy. A more distal clamp is applied to the esophagus, which is divided between the clamps and the antimesenteric border of the jejunum burned off by cautery. The end of the esophagus and a contiguous antimesenteric opening on the jejunum now project from the single remaining clamp. An anterior continuous Cushing suture is inserted over the clamp between the esophagus and jejunum, which is tightened as the clamp is withdrawn (Fig. 5B). The line of anastomosis is reinforced by additional anterior sutures and it is supported by means of sutures applied between the jejunum and diaphragm (Fig. 5C) with perhaps a reinforcing flap turned down from the diaphragm, as has been suggested by Lahey.

Supradiaphragmatic esophagogastrectomy with a single clamp (Fig. 6). Through a thoracic approach the diaphragm is divided, the upper part of the stomach is liberated, brought into the thorax and divided by cautery between clamps. The lower end of the esophagus is liberated to a point well above the lesion, where two rows of sutures are introduced uniting the posterior surface of the distal end of the stomach, which has been brought through the diaphragm, with the posterior surface of the esophagus (Fig. 6A). The single clamp then is applied across the esophagus, below the sutures and the stomach just below its clamped end. A second more distal protective clamp is placed across the esophagus alone. The esophagus is divided between the clamps and the end of the stomach with its clamp burned off by cautery. This leaves the lower end of the esophagus and the upper end of the stomach clamped together in a single clamp over which a continuous Cushing suture is inserted, as shown in Figure 6B. The Cushing suture is tightened as the clamp is slightly opened and withdrawn. Additional anterior and lateral sutures further invaginate the end of the esophagus into the stomach, as shown in Figure 6C. Past experiences impress one with the danger of necrotizing infections from an open suture of the esophagus.

ASEPTIC GASTROENTEROSTOMY

Aseptic gastroenterostomy may be performed by crushing together a fold of stomach with a longitudinal fold of jejunum after the plan of a side-to-side intestinal anastomosis. We have used a similar procedure for a cholecystoduodenostomy. In all these anastomoses particular care should be taken to bring folds of the underlying mucous membrane through the clamp; otherwise, the anastomosis will fail.

SINGLE CLAMP METHOD FOR RESECTION OF THE HEAD OF THE PANCREAS FOR CANCER

Single clamp method for resection of the head of the pancreas for cancer has the advantage of eliminating soiling of the wound field by bile or gastrointestinal contents which activate pancreatic ferments, and also of simplifying a one stage operation. The lower part of the stomach, the duodenum to its third portion, and the head of the pancreas are liberated *en masse*, the common bile duct is divided between ligatures, and the duodenum is divided near its third portion by cautery between clamps. The pancreas is divided and the retained end is closed with ligatures and sutures and covered by omentum. The liberated portion of stomach, duodenum, and pancreas is turned out of the abdomen. The distal end of the duodenum is closed by inverting sutures with removal of the clamp, and the fundus of the gall bladder is liberated. The posterior surface of the jejunum about one-half meter from the ligament of Treitz is sutured across the posterior surface of the stomach. The liberated fundus of the gall bladder is sutured on the anterior surface of the attached jejunum just below its antimesenteric border. A single clamp now is applied across the stomach, jejunum, and gall bladder, narrow segments of the last two with contained lumina projecting above the clamp. A second clamp is applied across the stomach 5 millimeters above the first, and the stomach is divided between the clamps and the projecting folds of jejunum and gall bladder are burned off with cautery. A continuous suture then is introduced over the clamp between the anterior face of the stomach above and the anterior surfaces of the gall bladder and jejunum below, which is tightened as the clamp is withdrawn. Additional anterior sutures are used to reinforce the anastomosis and further to invert the gall bladder and edge of the jejunum into the stomach. The stomach and attached segment of jejunum then are invaginated with the thumb and finger to open the stomas. Obviously the gall bladder also may be applied lateral or posterior to the loop of jejunum.

ANESTHESIA

Spinal anesthesia, usually with a mixture of from 1 to 1.4 cubic centimeters of 1 per cent pontocaine mixed with an equal quantity of 10 per cent procaine, has been used. For the substandard patient this has been followed by a slow intravenous drip of 5 per cent glucose solution with or without minimal amounts of 2.5 per cent pentothal sodium solution and at times typed and citrated blood. Local and splanchnic block with 1 per cent epinephrinized procaine has been used freely.

SUTURES

Fine catgut, silk, and plain and stranded alloy steel wire have been used for the inner row of gastric and intestinal sutures. Interrupted No. 36 plain or stranded alloy steel wire has been used for the peritonealizing outer row of sutures as this material does not cause peritoneal reactions or adhesions. The possibility of a suture being burned under the clamp has been considered and a protective strip of wet tape used but no accident has occurred from this source. At this writing there has been no leakage along suture lines following the single clamp method. All abdominal wounds were closed with interrupted usually layer sutures of alloy steel wire.

HEMORRHAGE

None of the intestinal resections have had intraluminal hemorrhage. After 20 resections of the stomach by the single clamp method, including one for massive hemorrhage, there was little or no bleeding. Then two patients had a heavy hemorrhage through the Wangensteen gastric tube. The stomach had been divided by cautery and the edge of the stomach burned off level with the clamp. Wangensteen leaves a short section of the viscus projecting above the clamp and also applies a high frequency coagulating current to the clamp. He writes that thus he has had no hemorrhage in over 200 resections. After this method was adopted, 3 patients developed necrosis in the abdominal wound, omentum, and region of the duodenum and pancreas, areas in contact with the wet salt pads which were under the clamps to which the high frequency current was applied, probably too intensely and for too long a time. Two of these patients died with degrees of necrosis of the head of the pancreas. One recovered after excision of chalky necrotic tissue from the depths of the abdominal wall and a jejunojejunostomy. We have since used only the galvanocautery.

DRAINAGE

In all cases a slender, double lumen drainage tube of glass or alloy steel connected to a motor-driven suction pump is left in peritoneal cavity until blood, serum, bile, or other liquids are no longer withdrawn, usually 12 to 24 hours.

COMPLEMENTAL ENTEROSTOMY

In one stage resections of the colon, especially of the descending colon and sigmoid, the most dangerous of intestinal resections, it is wise to do a complemental appendicostomy or enterostomy at the time of operation. Guided by a hand within the abdomen, the appendix and mesoap-

pendix are pulled through a 1 or 2 centimeter stab wound. Dressings are applied, the tip of the appendix or of a cone of cecum cut off and a No. 14 F. catheter passed into the cecum, tied in, and kept open by irrigation. Otherwise, should a patient develop abdominal cramps with localized or diffuse intestinal distention not relieved by Wangensteen aspiration, we promptly deflate by tying a No. 14 F. catheter in the appendix or distended bowel. A small muscle-splitting incision made under local anesthesia is used. Gentle irrigations are continued with weak peroxide of hydrogen until the bowel empties. Such operations done without delay have a low mortality and may be life-saving. The Miller-Abbott tube is not advised for colonic obstruction.

RESULTS

Sixty-five resections, 35 of the stomach, 30 of the intestine, have been done by aseptic single clamp methods as described. There were 9 end-to-end resections of the transverse colon or its flexures, 8 of the ileum, cecum, and ascending colon, 8 of the sigmoid or rectosigmoid, 1 of nearly 9 feet of ileum for carcinoid obstructing bowel and blood supply 1 of both jejunum and transverse colon, 1 of both sigmoid and ileum, and 2 of both ileum and rectum. All intestinal resections were for carcinoma except one for ileoperineal and rectoperineal fistulas following operations elsewhere for lymphogranuloma.

Despite the number of necrotic carcinomas removed there were only two operative infections of the abdominal wound and one localized intraperitoneal abscess (end-to-end resection of the sigmoid). The majority of patients were permitted out of bed by the 5th to 8th post-operative day and to go home on the 11th to 14th day.

In the gastric series 4 patients died in the hospital, 1 of a true lobar pneumonia 8 days after complete gastrectomy for lymphosarcoma which extended into both esophagus and duodenum; a second from bronchopneumonia, gastric hemorrhage and purulent infiltration about the duodenum, following partial gastrectomy for subacute perforation of a chronic duodenal ulcer. The third, a woman of 70 years, and the fourth had the postoperative pancreatitis with extensive fat necrosis, previously mentioned. In the intestinal series there was one death from renal suppression and ileus without peritonitis which may be attributed to the operation. Two died in the hospital from the progress of advanced ineradicable carcinoma. One, who had large openings from the bladder, small intestine, and rectum into a cancerous pelvic cavity, was given a measure of comfort for 6 weeks by abdominal resection of the fistulous small bowel and a sigmoidostomy. The second, who had a perforated carcinoma of the sigmoid invading the ileum and discharging through the anterior abdominal wall lived about 2 months after a combined Mikulicz and oblique resection of the ileum without the anastomosis breaking down. Both previously had been operated upon elsewhere. The fourth hospital death in the intestinal series, of a 74 year old man, occurred suddenly from the intravenous use of 5 per cent glucose after resection of 110 centimeters of ileocecum. A glucose infusion several days previously had been stopped on account of precordial distress. At the second infusion the symptoms recurred but the glucose was not discontinued. There was no peritonitis and the anastomosis was found watertight and not obstructed.

SUMMARY

In a dependable aseptic anastomosis lies the best hope of reduction in the mortality and morbidity of gastric and intestinal resections. A one stage, single clamp aseptic method is described adaptable to any simple or complicated resection and anastomosis of the gastrointestinal tract including subtotal pancreatectomy. Technical modifications to overcome various complications are detailed. From 65 resections of the stomach or intestine the morbidity has been low, and no death attributed to defect in the anastomosis has occurred.

REFERENCES

1. Babcock, W. W. Am. J. M. S., 1939, 46: 187.
2. Branch, J. R. B. Surg. Gyn. Obst., 1928, 47: 678.
3. Brenizer, A. S. Am. J. Surg., 1934, 24: 863.
4. Gatch, W. D. J. Am. M. Ass., 1912, 59: 185.
5. Dennis, Clarence. Surgery, 1939, 5: 548.
6. Doyen, E. Nouveau procede d'enterorrhaphie. Eleventh Congress francaise, Paris, 1897.
7. Furniss, H. D. Am. J. Surg., 1934, 23: 379.
8. Halsted, W. S. Bull. Johns Hopkins Hosp., 1891, 2: 1–4.
9. Martzloff, K. H., and Burget, G. E. Arch. Surg., 1931, 23: 26.
10. Moszkowicz, L. Wien. klin. Wschr., 1908, 21: 1593.
11. Ibid., 1909, 22: 848.
12. O'Hara, M., Jr. Am. J. Obst., S. Louis, 1900, 42: 81.
13. Parker, E. M., and Kerr, H. H. Bull. Johns Hopkins Hosp., 1908, 19: 132.
14. Perret, C. H. Surg., Gyn. Obst., 1927, 44: 378.
15. Pleth, V. Am. J. Surg., 1906, 20: 170.
16. Rankin, F. W. Surg. Gyn. Obst., 1928, 47: 78.
17. Reichert, F. L., and Holman, E. Bull. Johns Hopkins Hosp., 1925, 36: 212.
18. Rostowzew, M. I. W. Arch. klin. Chir., 1907, 82: 462.
19. Scarff, J. E. 1926, Am. J. Surg., 83: 490.
20. Ssamarin, N. N. Am. J. Surg., 1937, 38: 351.
21. Stone, H. B. Surg. Gyn. Obst., 1937, 65: 383.
22. Wangensteen, O. H. Surg. Gyn. Obst., 1940, 70: 59.
23. Ibid., 1941, 72: 257.

THE SURGICAL TREATMENT OF CARCINOMA OF THE PHARYNX AND UPPER ESOPHAGUS

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THE pharynx may be divided into three parts: an upper third or nasopharynx, an intermediate or oral pharynx, and a lower portion known as the laryngopharynx or hypopharynx.

Carcinoma of the nasopharynx is not amenable to surgical treatment but some growths involving the oral pharynx or hypopharynx may be treated surgically with a fair prospect of success.

Growths originating in the hypopharynx may early involve the opening of the esophagus and, conversely, upper esophageal growths may spread to the hypopharynx. There is no essential anatomical or histological difference in structure of the esophagus or pharynx, and tumors arising in these areas are identical in their pathology and method of spread.

The vast majority of these tumors are epidermoid carcinomas and are slow growing and relatively late in forming metastases. The method of spread is to neighboring lymph nodes. Distant metastases when occurring are usually found in the advanced stages of the disease.

The usual symptom produced by these tumors is difficulty in swallowing solid or dry foods, often accompanied by a feeling of discomfort in the neck. Occasionally there are voice changes due to edema or involvement of the muscular structure of the larynx.

The upper 3 or 4 inches of the esophagus may be exposed by the same cervical approach as in dealing with pharyngeal lesions.

In cancer of the oral pharynx the larynx may be involved, and in such cases it is essential to remove larynx and pharynx *en bloc*. This is a mutilating type of operation, and many patients and physicians hesitate to undergo or recommend such extensive procedures. However, as it is possible to reconstruct the pharynx so as to permit taking food in a normal manner, the loss of the larynx does not in itself seem too great a sacrifice for the saving of life.

The patients suitable for operation should be prepared by blood transfusions when necessary or by a preliminary course of intravenous therapy.

From the Department of Surgery, University of Toronto. Presented in the Cancer Symposium before the Clinical Congress of the American College of Surgeons, Boston, November 3–7, 1941.

Figure 1 illustrates a growth situated behind the cricoid and extending up to and involving the aryepiglottic folds and the arytenoids. This case is recorded as Case 1.

The general details of the operation are as follows. The anesthetic is given by mask for the first part of the operation and consists of cyclopropane, gas and oxygen, or ether. The exposure is secured by turning back a flap of skin including the platysma, as illustrated in Figure 2. This is based on the right side of the neck, and the skin is reflected so as to expose the sternomastoid muscle. This muscle should then be removed. The isthmus of the thyroid gland is divided and the right lobe is removed, the surrounding tissue being protected by gauze soaked in acriflavine. The trachea is now freed and divided immediately below the cricoid cartilage and the larynx is packed from below. A sterile tube fitted with an inflatable cuff is then placed in the trachea and

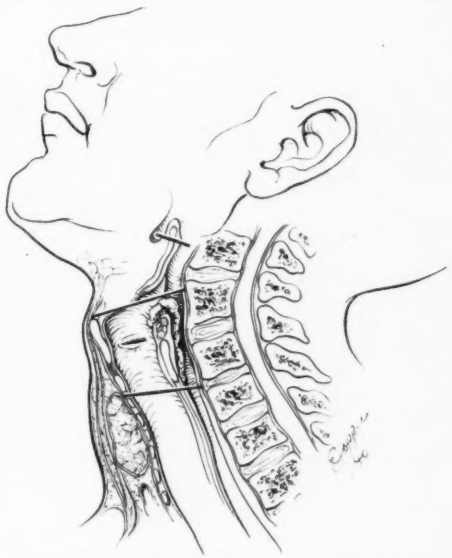

Fig. 1. Extensive retrocricoid lesion involving superior aperture of larynx. For such cases it is necessary to remove larynx and pharynx *en bloc*, as illustrated in text and represented by Case 1.

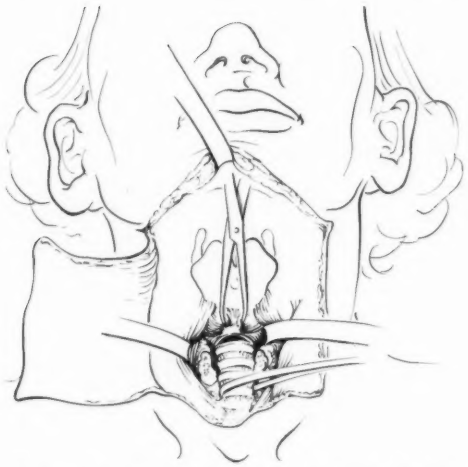

Fig. 2. Large skin flap reflected, isthmus of thyroid divided, trachea exposed, and position in which it is divided.

Fig. 3. Intratracheal tube in position. Pharynx has been divided below hyoid. Esophagus mobilized ready for division.

the cuff is blown up to make it air tight. The anesthetic is then continued by means of this tube (Fig. 3).

The esophagus is mobilized and a tape is passed around it and the entire pharynx is separated from the prevertebral region. The pharynx is then divided just below the hyoid bone or the body of the hyoid may be removed, though it is best retained if possible. This is illustrated in Figure 3.

The esophagus is divided at a convenient point and the pharynx and larynx are removed in one block. After careful ligation of all bleeding points, the skin flap is then laid across the prevertebral

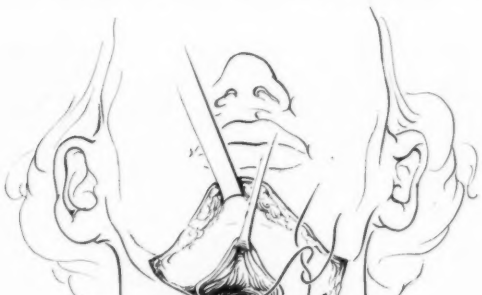

Fig. 4. Method of using flap for reconstruction of pharynx, sutures being placed above. The esophagus is now ready for the placing of suture to lower margin of skin flap.

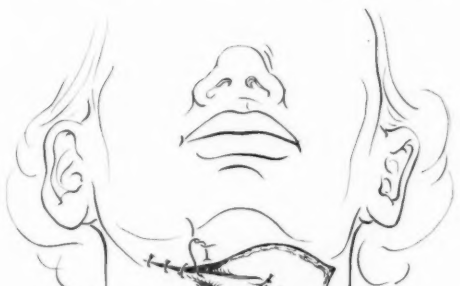

Fig. 5. First stage completed, showing line of esophagus sutured below, upper suture line to pharynx now concealed, remainder of skin flap being used to close raw surface as far as possible before Thiersch grafts are applied.

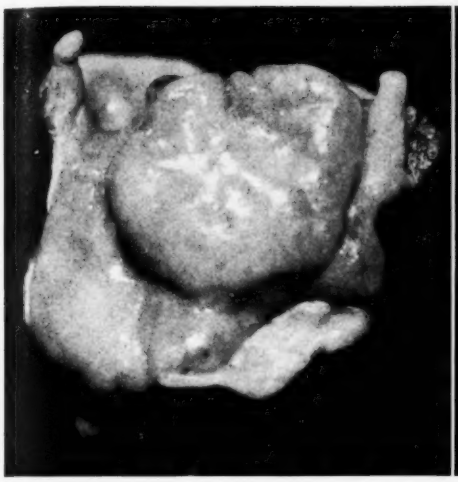

Fig. 6. Photograph of specimen from behind showing position of growth. (Case 1).

Fig. 7. Photograph of specimen from above showing involvement of superior aperture of larynx. (Case 1).

space and secured in position by two vertical lines of interrupted catgut sutures about 1 inch apart. The upper edge of the skin flap is sutured to the cut end of the pharynx by a series of interrupted chromic catgut sutures placed close together. The lower edge of the flap is sutured to the esophagus (Fig. 4). The remainder of the skin flap is then folded across the middle line and sutured to the deep fascia as illustrated in Figure 5.

A Levine tube is passed down the esophagus to the stomach and the upper end by way of the mouth through the nose. The residual raw surface on the left side of the neck may be made smaller by a series of sutures bringing the skin over for some distance. Thiersch grafts are then used to cover the remaining raw surface.

The patient is fed through the Levine tube. Figure 8, taken 5 weeks after operation, shows the wounds healed and the lateral sinus in the neck. The Thiersch grafts have taken and the tracheal opening is seen just above the sternum.

The next step is closure of the lateral sinus in the neck. Two diagrams (Figs. 9 and 10), illustrate the way this is done. The margins of the sinus are undercut slightly and turned in by a series of interrupted catgut sutures so placed that the knots are in the pharynx. A second layer of sutures inverts this suture line further.

The now complete tube is allowed to slip back into the neck, and the skin is closed completely. The photograph (Fig. 11) shows the final result. The Levine tube is retained for 2 weeks or until the wound has healed, after which the patient is allowed first fluids and then 2 weeks later soft foods, and eventually a full diet may be given.

This patient was provided with an artificial larynx but it is well known that such patients acquire a method of speaking in a whisper loud enough to be heard and understood.

Fig. 8. Photograph of patient (Case 1), wounds healed, permanent opening of trachea and lateral fissure in neck ready for closure.

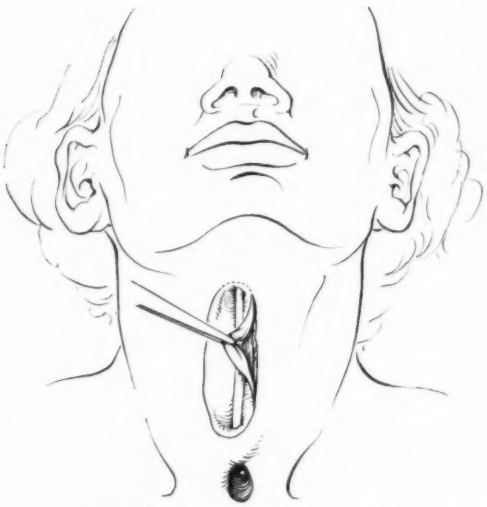

Fig. 9. Method of closing lateral fissure by incising and undercutting the skin.

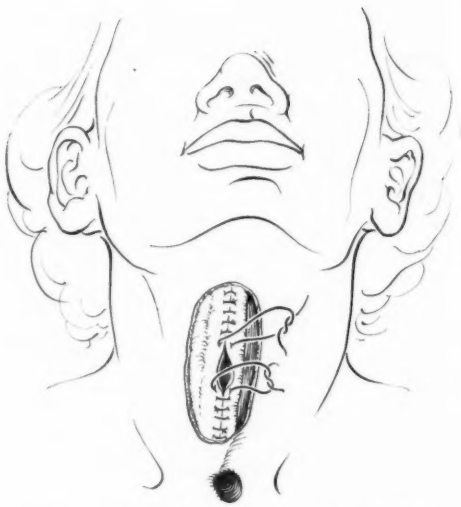

Fig. 10. The margins of the skin tube are here being sutured.

In some cases the growth may be less extensive, and it is possible to preserve the larynx. The lower pharynx may be removed and an immediate reconstruction done. The typical site of such a lesion is shown in Figure 12, Case 2.

The same type of incision is made. A flap of skin is turned back and a line of cleavage is found between the right lobe of the thyroid and the carotid sheath. The thyroid is used as a means of retracting and rolling the larynx and trachea over to the left. The carotid vessels and jugular vein are retracted outward. The superior and inferior thyroid vessels are best divided between ligatures so as to permit a wide separation between structures within the carotid sheath and the larynx. An incision is made through the constrictor muscles along the posterior margin of the wing of the thyroid cartilage and the mucous membrane is separated by blunt dissection from the pyriform fossa. This dissection is carried across the middle line separating mucous membrane from cricoid cartilage and posterior cricoarytenoid muscle as far up as the tips of the arytenoids. The mucous membrane is separated in the left pyriform fossa. An opening is made in the lateral wall of the pharynx and a view of the tumor is obtained. The pharynx is divided above the growth. The esophagus is mobilized below and divided at a convenient level. All bleeding points are carefully ligated, and the flap of skin is placed across the prevertebral region behind the larynx and secured in place by two lines of interrupted catgut sutures. The margins of the skin flaps are sutured to the esophagus below and the pharynx above, as illustrated in Figure 13. The larynx is allowed to come back into its proper position, the right lobe of the thyroid is replaced, or, if large, is removed, and the remainder of the skin flap is folded across

Fig. 11. Photograph of patient (Case 1), all wounds healed, reconstruction completed, taking food normally and ready for discharge from hospital.

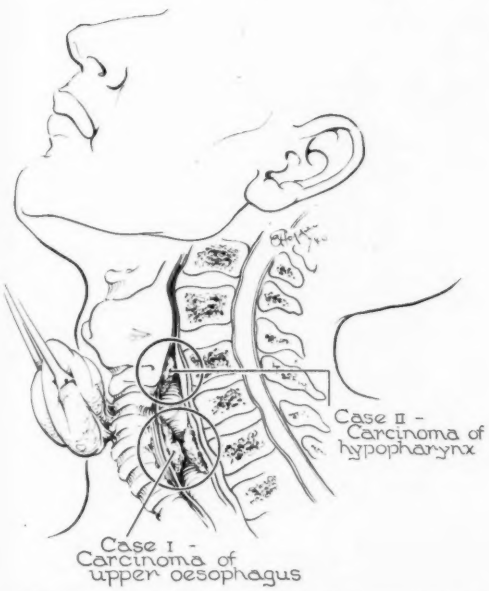

Fig. 12. Sites of lesion in conservative operations on retrocricoid growths (Case 2). Also position of upper esophageal lesions (Cases 3 and 4). Larynx is saved, lobe of thyroid used for displacing trachea.

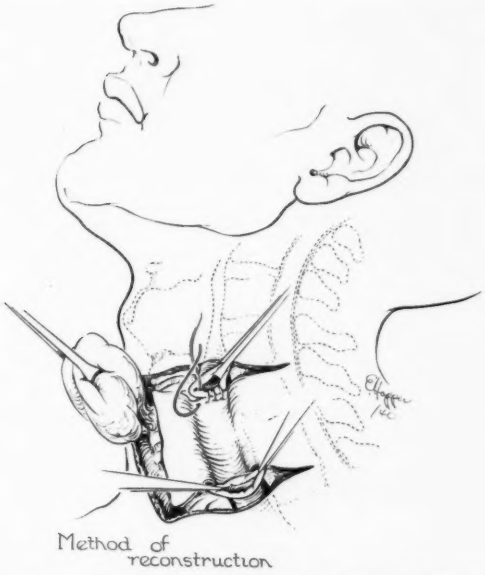

Fig. 13. Method of reconstruction used in Cases 2, 3, and 4.

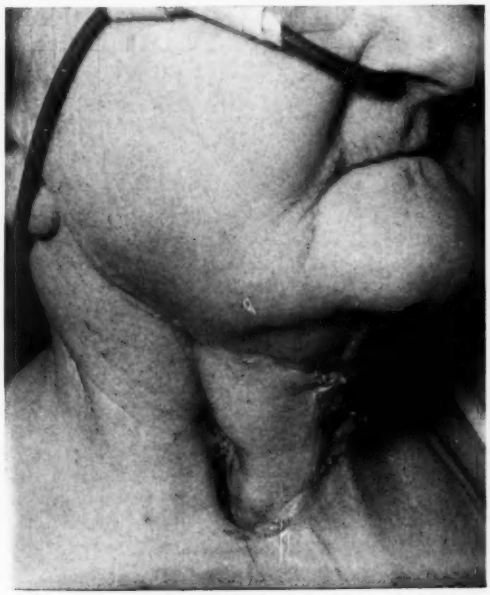

Fig. 14. Photograph of patient in Case 2 just before closure of lateral fissure.

Fig. 15. Reconstruction completed. Patient able to take normal food and ready for discharge from hospital (Case 2).

Fig. 16. Roentgenogram of filling defect in upper esophagus (Case 3).

Fig. 18. Photograph of lesion in upper esophagus (Case 3).

the thyroid, larynx, and trachea. This leaves a defect in the skin over the left side which can be made smaller by a few sutures pulling the edges together. The balance of the raw surface is covered with Thiersch grafts. A Levine tube is passed down to the stomach and the upper end is brought out through the nose. The lateral fissure in the neck can be closed in about 5 weeks' time. The method of doing this has already been described.

Carcinoma of the upper end of the esophagus may be treated in the same manner (Fig. 12, Cases 3 and 4). The esophagus was exposed by the same method of approach, the lower end of the pharynx was mobilized, and the tumor was removed. The reconstruction is somewhat easier

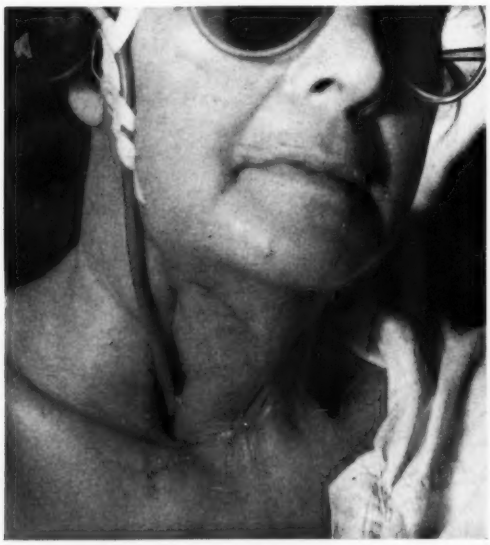

Fig. 17. Photograph of patient after excision of upper esophagus, ready for closure of lateral fissure (Case 3).

Fig. 19. Photograph of patient with operation completed, ready to leave hospital (Case 3).

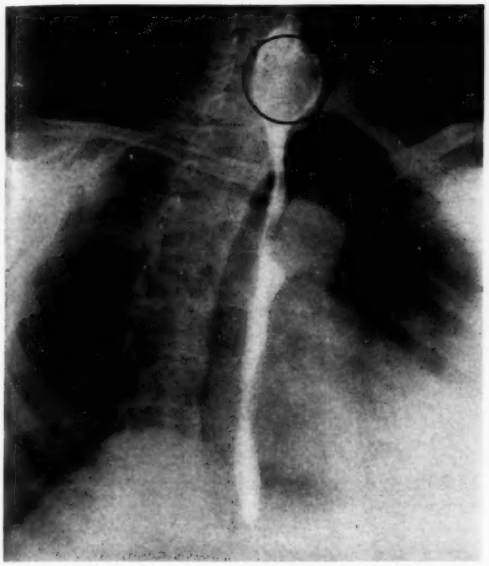

Fig. 20. Roentgenogram showing filling defect produced by polypoid growth in upper esophagus (Case 4).

than in the case of growths originating in the pharynx. The skin flap is made use of in the same way for reconstruction of the esophagus. Figure 13 serves to illustrate this equally well.

CASE REPORTS

CASE 1. (Figs. 6, 7, 8, and 11.) Mrs. Eliz. B., aged 50 years, was admitted to the hospital November, 1934, complaining of hoarseness and pains in her neck for 6 months. The trouble began with a feeling of soreness of the left side of the neck below the jaw and difficulty in swallowing solid

Fig. 22. Photograph of specimen removed at operation (Case 4).

food. Difficulty in swallowing had increased. She had lost 15 pounds in weight in past 4 months. Laryngoscopic examination revealed a tumor in the retrocricoid region, extending upward to the superior aperture of the larynx and involving the left pyriform fossa. Biopsy specimen showed epidermoid carcinoma.

Operation was performed December 19, 1934. Exposure was made by flap of skin based on the right side. The isthmus of the thyroid was divided, the trachea exposed. The trachea was divided below the cricoid. The pharynx was opened above the upper border of the thyroid. The pharynx was divided below the hyoid. The esophagus was divided about 1½ inches below its upper end. Immediate first stage reconstruction of pharynx and esophagus was done. The cut end of the trachea was sutured to the skin. On April 2, 1935, closure of lateral fissure in the neck was done. On April 15, 1935, the Levine tube was removed. Patient was allowed to swallow fluids. On April 20, 1935, she was taking soft diet. She was discharged April 27, 1935, at which time she was taking full diet.

This patient lived for 2 years but died of metastases in her neck.

CASE 2. (Figs. 14 and 15.) Mrs. Emily H., aged 62 years, admitted to the hospital November 18, 1939. She

Fig. 21. Photograph of patient (Case 4) just before closure of lateral fissure.

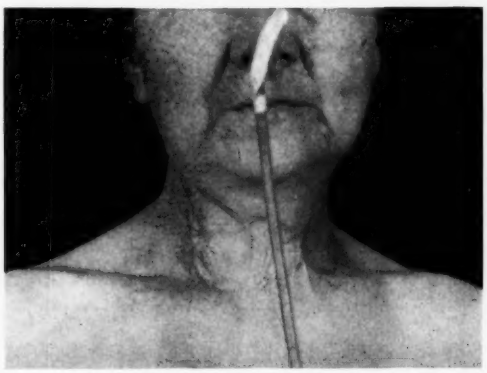

Fig. 23. Photograph of patient, lateral fissure closed, Levine tube to be removed (Case 4).

complained of difficulty in swallowing for 4 years; inability to swallow solid foods for past 3 months; and recently difficulty in getting fluids down. On examination there was found a growth involving the lower pharynx and left pyriform fossa, which bled easily. Biopsy specimen showed epidermoid carcinoma.

Operation was performed on December 15, 1939. The larynx and trachea were displaced to the left. The pharynx was divided just below the superior aperture of the larynx. The mucous membrane was separated from the pyriform fossa and back of the cricoid cartilage. The esophagus was divided 2 inches below its upper end, and an immediate reconstruction of the pharynx and upper esophagus was done in the manner described.

Figure 14 shows patient 5 weeks after operation with skin wound healed and a Levine tube passing down to the stomach through the nose as means of feeding the patient. On February 21, 1940, the lateral fissure in the neck was closed, thus completely reconstructing the esophagus and pharynx. On March 20, 1940, the Levine tube was removed. Patient was allowed to take fluids by mouth at first, followed by soft foods in a week, and was on a full diet in the third week, care being taken to cut up food into small pieces. On January 18, 1940, Figure 15 was taken, 4 months after final operation on return to follow-up clinic. Patient was able to take all types of food satisfactorily. In February, 1942, patient was in good health and taking normal diet.

Case 3. (Figs. 16, 17, 18 and 19.) Mrs. J. H., aged 52 years, was admitted to the hospital in March, 1939. She had suffered from discomfort in swallowing for about 1 year, the condition gradually increasing until on admission only fluids could be taken. Esophagoscopic examination showed a tumor about 1½ inches below the orifice of the esophagus. Biopsy specimen showed epidermoid carcinoma. The x-ray film showed a filling defect (Fig. 16). Operation was performed on March 23, 1939. The larynx and trachea were displaced to the left. The lower pharynx and upper 3½ inches of esophagus were removed (Fig. 18). Immediate first stage reconstruction was done. On May 15, 1939, the photograph, Figure 17, was made and showed the wound healed. The lateral fissure was ready for closing. On June 1, 1939, the fissure was closed and the Levine tube was removed. Patient was able to take fluids (Fig. 19). She remained well for 12 months, and then began to have difficulty in swallowing. A tumor appeared from below the clavicle, attached to, and infiltrating, the trachea. This was believed to be due to development of secondary carcinoma in glands invading trachea. She died in September, 1940.

Case 4. (Figs. 20, 21, 22, and 23.) Mrs. S. McC., aged 58 years, was admitted to the hospital July, 1941, complaining of difficulty in swallowing for 8 months; also some pain in region of the suprasternal notch when swallowing. X-ray examination showed a filling defect in the upper end of the esophagus (Fig. 20). Esophagoscopic examination revealed a polypoid growth 1 inch below the orifice. Biopsy specimen showed epidermoid carcinoma.

Operation was performed August 7, 1941, and consisted of removal of the lower pharynx and upper 3 inches of the esophagus (Fig. 22), with first stage of reconstruction done immediately. Larynx and trachea were displaced by method already described. Figure 21 shows the wound in the neck healed. The lateral fissure was ready for closing. In October, 1941, the lateral fissure closed. Figure 23 shows the condition when patient was discharged from the hospital. She was able to take solid food with comfort. In February, 1942 patient was alive and well and taking normal diet.

SUMMARY

Methods of removing suitable growths involving the lower pharynx and upper esophagus are described. When the larynx is involved, a complete removal of larynx and pharynx is suggested as illustrated in Case 1. A conservative operation for removal of early hypopharyngeal carcinoma, preserving the larynx, is described in Case 2. Tumors at the upper end of the esophagus may be removed as illustrated in Cases 3 and 4. In all cases it was possible to reconstruct the pharynx and upper esophagus so as to permit the taking of normal food. Unfortunately, many cases are seen by the surgeon in the advanced stage, but with early diagnosis and operation without delay, there should be a reasonable chance of effecting a cure. In 1 or 2 cases, because of respiratory difficulty in the first day or two after operation, a tracheotomy has been necessary as a temporary measure. Indeed, I believe that it is wise to do a tracheotomy in all cases. The tube may usually be removed after about a week. The fact that the pharynx and esophagus can be reconstructed should encourage both physician and patient.

THE LAMINAGRAPH AS AN AID IN THE TREATMENT OF CHRONIC OSTEOMYELITIS

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New York, New York

ONE of the difficulties often encountered in the treatment of chronic osteomyelitis is the accurate localization of abscesses which give rise to recurrent attacks of pain, swelling, and fever. These cavities contain pus, or less frequently granulation tissue, usually in the midst of thickened, sclerotic bone, the density of which is such that ordinary x-ray films fail to reveal them. One or more sinuses may communicate with the abscess cavity, but the tract often is so long and tortuous that it cannot be clearly followed in the ordinary roentgenogram even after injection with an opaque substance. Efforts to find the cavity by excavation of the bone without any definite knowledge of its whereabouts usually are unsuccessful.

When a laminagraph was acquired by the New York Orthopaedic Hospital in the spring of 1941, it occurred to us that this instrument, which is capable of making a clear and detailed roentgenogram of any plane desired through any substance, might be used to solve this problem. The fundamental principle[1] of the laminagraph is that the tube and film move during exposure in such a way that the roentgenographic shadow of a selected plane in a body remains stationary on the moving film while the shadows of all other planes have a relative displacement on the film, and are therefore blurred to varying amounts, depending mainly on the distance of such planes from the one selected. The effect of motion and its attendant blurring is two-fold. First, it permits good visualization of objects which would otherwise be obscured, when roentgenographed in the normal position, by large dense overlying or underlying structures in a direct line with the desired object and target. During laminagraphic motion an appreciable part of the exposure is made while obscuring structures are not in a direct line with the object to be visualized, and therefore, clearer views of this object are obtained. Second, it minimizes the disturbing effect of superimposed shadows because it blurs the image of fine structures not in the plane to be visualized.

From the New York Orthopædic Dispensary and Hospital.

[1]Jean Kieffer. Am. J. Roentg., 1938, 39:479–513.

CASE 1. The first patient was a 19 year old girl (Fig. 1), who had had osteomyelitis of the right femur since the age of 13 months. At no time since the onset had the disease become completely healed. The entire extent of the femur was involved. The bone was enlarged, thickened, sclerosed, and was deformed as a result of the infection and numerous operations. There was a bony ankylosis of the knee. Several sinuses opened and discharged from time to time. The most troublesome feature of the case was recurrent attacks of pain and swelling in the region of the knee, and on these occasions a discharge usually took place from a sinus on the inner side of the knee. A number of operations had been performed, both in this and in other hospitals, in an effort to eradicate the focus of infection giving rise to these exacerbations. The last attack upon the bone had been made elsewhere the previous summer. After each of these operations the pain was made more severe.

The laminagraph was used showing planes of the lower part of the femur at intervals of 1 centimeter. They revealed a cavity in the outer portion of the bone and showed a sinus tract communicating with it and extending obliquely inward to the medial surface. These facts were made more clear by droplets of lipiodol which had been injected the previous summer. The sinus tract was injected with methylene blue and the bone was explored. Upon the cutting away of extremely hard, sclerotic bone above the lateral condyle, an abscess cavity containing thick, yellow pus tinged by methylene blue was found in the place indicated by the laminagrams. This cavity and the sinus tract communicating with it were thoroughly excavated. The cavity was lightly packed with sulfathiazol. Recovery was marked by the absence of pain and fever and ended with obliteration of the sinus tract by granulation tissue over which epithelium grew.

The second case with 2 separate abscesses demonstrates the possibility of more than one abscess cavity in bone.

CASE 2. This patient is a 33 year old female who was admitted in 1933 for arthrotomy of the left knee because of suppurative arthritis and popliteal abscess. In 1935 cardinal signs of inflammation reappeared in the left knee, but this subsided with rest and hot packs. She returned again in 1940 with a popliteal abscess which was incised and drained. At the same time the lower femur was explored but there was no evidence of active osteomyelitis. On the 11th postoperative day a fracture occurred through the distal shaft of the femur when the patient started to sit down on a chair. Good reduction of the fracture was obtained by the insertion of tongs in the supracondylar region with traction. The fracture healed. The patient again returned in April, 1941, at which time there were five draining sinuses in the lower femoral region. Each sinus was injected with lipiodol and laminagrams were obtained. Incision and drainage followed with confirmation of two bone abscesses as demonstrated by the laminagrams.

CASE 3. Male, aged 40 years (Fig. 2). At the age of 7 the right knee became swollen and painful, the swelling sub-

a b c d

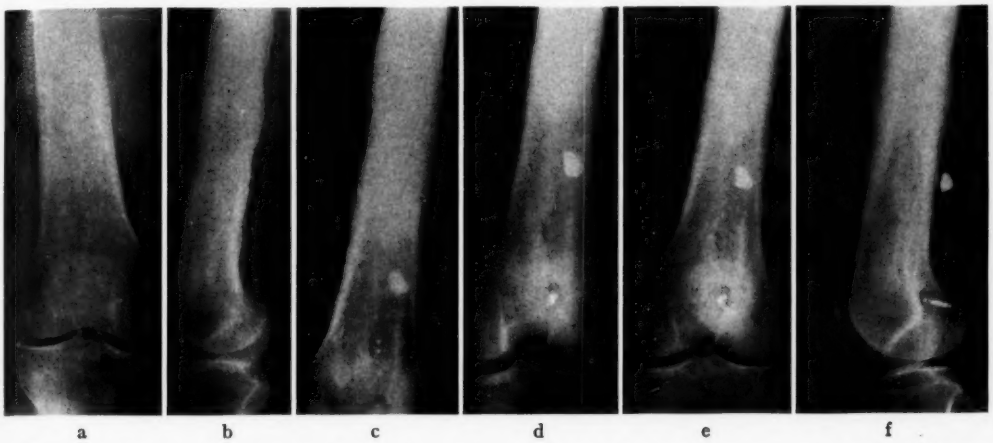
e f

Fig. 1. a and b are routine roentgenograms in the anteroposterior and lateral positions showing irregular bony sclerosis and decalcification. No evidence of sequestra or periosteal reaction to indicate possible site of active osteomyelitis. c and d are laminagrams. c shows lipiodol in bone sinus tract which represents an abscess cavity. The sinus tract extends from the intercondylar notch laterally and upward to the lateral border of the femur proximal to the lateral femoral condyle. d reveals the lipiodol in the intercondylar notch. e and f are routine roentgenograms following the operation.

siding in 4 months. At the age of 14 a popliteal abscess developed and it was incised. The patient was free of recurrence until 1937. In August, 1938, a bone abscess in the lower end of the femur, which communicated with a popliteal abscess was explored and drained. However, drainage has continued up to the present time. Laminagraphic examination was made after the injection of lipiodol of the two draining sinuses. It demonstrated a cavity in the lower end of the femur, which also was shown in the ordinary x-ray films. It also proved that no other cavities were present. This patient has not yet been subjected to operation.

The last case (Fig. 3) demonstrates the increase of bone detail by laminagraph as compared to the usual x-ray examination. In this case the diagnosis was made possible only by the use of this method.

CASE 3. The patient, a 7 year old girl, who was admitted to the hospital in October, 1941. Symptoms were pain in the left knee for the last 6 months, especially noticeable in the evening, and a slight limp periodically. Signs were slight limitation of motion and some spasm in the muscles of the left hip. Routine anteroposterior and lateral x-ray films revealed slight bone demineralization of the left femoral neck. The tuberculin test was negative; sedimentation rate was 23, and the white blood cell count was 13,00 with 47 per cent neutrophils, 49 per cent lymphocytes, 3 per cent mononuclears, and 1 per cent eosinophils. The laminagrams showed a cavity in the midfemoral neck, about 1 centimeter in diameter. Surgical exploration revealed moderate increase of clear yellow fluid in the hip joint, and a synovial membrane was moderately hypertrophied. Several drill holes were made in the region of the cavity.



a b c d e f

Fig. 2. a and b are roentgenograms showing irregular bony sclerosis and decalcification in lower third of femur. c and d are laminagrams which show the lipiodol within the large bone abscess in lower femur following the injection of sinuses. e and f are plain roentgenograms after the injection of the lipiodol. The media appears to be within the bone and not so clearly demonstrated as on the laminagrams. Then the opaque media on the skin surface may cause confusing shadows on plain roentgenograms but not in the laminagrams.

a b c d

Fig. 3. a and b represent routine anteroposterior and lateral roentgenograms which show irregular decalcification of the bone throughout the area of the femoral neck. c and d are laminagrams which were taken at different levels. c reveals a 1 centimeter cavity which is in the neck of the femur. c is in better focus than d. The cavity is not clearly discernible on routine roentgenograms.

CONCLUSIONS

1. An increase of bone detail is available by the use of the laminagraph.

2. The laminagraph affords better localization of a bone abscess with regard to both site and level.

3. The laminagraph may help in the prevention of operation for just one abscess when more may be present.

4. The use of lipiodol in draining sinuses is suggested when roentgenographic examinations are made.

A ROENTGENOLOGICAL STUDY OF THE POSTOPERATIVE ABDOMEN

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ADISTENTION varying in degree very frequently develops in from 24 to 96 hours following abdominal surgery. The operative procedure may have been of such a magnitude that a moderate degree of distention is anticipated by the surgeon—the so called "gas pains." Too frequently, the distention continues or becomes quite severe and may be accompanied by pain. But this, too, is accepted as the usual aftermath of a major abdominal surgical procedure. However, a certain percentage of these cases, as will be shown later, are of a mechanical obstructive nature and not a paralytic ileus brought on by stimulation of the sympathetic nerve.

Fortunately, only a small percentage of postoperative distention is based on a mechanical block. Of this small group, only part of them progress to require active therapy. It is this latter smaller group that we are interested in because, if a mechanical obstruction can be diagnosed early in a postoperative course and active therapy instituted, the late sequelae of a mechanical obstruction can be obviated. Distention of the colon is not included in this paper, although we have noted that a mechanical obstruction of the colon, by back pressure, can cause small bowel distention, giving the appearance of a mechanical obstruction.

Ochsner showed that if a mechanical block of the small bowel is allowed to continue untreated and the obstruction is low, the increasing interluminary pressure may cause pressure necrosis, gangrene of the bowel, peritonitis, and death. If the obstruction is high, vomiting will quickly occur with the resultant loss of fluid and chlorides. This may also cause the death of the patient (Wangensteen). In an uncomplicated case, mechanical obstruction can be clinically differentiated from paralytic ileus by the increased peristalsis of the bowel. In the postoperative patient a clinical differential diagnosis is more difficult. Mechanical obstruction may exist with little or no audible peristalsis and may be present without appreciable distention.

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The causes of postoperative mechanical obstruction are numerous. An adhesive band may have been overlooked at the time of the original operation. A small amount of fibrin may cause two loops of bowel to become adherent and so set up a mechanical obstruction. An internal herniation may occur. A loop of bowel may become adherent to a raw surface which had not been properly peritonealized. Another cause not often considered is a local focus of infection paralyzing the adjoining segment of small intestine by its toxic action on the muscle wall (Devine). This causes a mechanical block, producing a painless distention without local symptoms; or small bowel may become adherent to the local infection. At the time when upper cesarean sections were commonly performed, a great many obstructions occurred from adhesions of the bowel to the suture line by plastic lymph.

The clinical signs of mechanical obstruction may not appear until the 6th or 7th day after operation. Considering the seriousness of a mechanical obstruction, one must be concerned about every case of distention and use any means possible to differentiate the type. This can be done by a simple x-ray examination of the abdomen. In a recent article, Brunn and one of us (J.L.,2) outlined the differential diagnosis of mechanical block from paralytic ileus, as viewed on the x-ray film. They are as follows:

Mechanical obstruction	Paralytic ileus
1. A continuous distention to the point of obstruction.	1. Scattered loops of distended small and large bowel.
2. Loops few and large.	2. Loops many and small.
3. Dynamic appearance of bowel.	3. Adynamic appearance of bowel.

Many questions arose as to the accuracy of these findings especially when a few postoperative cases showed evidence by x-ray examination of mechanical block while the patient appeared well, clinically. Some of the questions we desired to answer were: (1) How much importance can we place on the x-ray findings in a case of distention? (2) What is the nature of postoperative distention? (3) Do factors such as anesthesia, type of surgery, technique of the surgeon or postoperative

treatment play a part in the occurrence of postoperative distention? (4) If a mechanical block is surgically treated, how soon does the bowel return to normal, as viewed on the film? (5) How much attention must be paid to a positive x-ray diagnosis of mechanical obstruction with minimal clinical symptoms? (6) What is the appearance of the small bowel on the x-ray film when part of it has been resected?

While we have not completely answered all these questions, we feel that by the cases we have studied, we can throw some light on the subject and give a working basis for treatment. Since the goal of all treatment is to reduce morbidity and mortality, it is most important that mechanical block be recognized early and that treatment be instituted to relieve the distention, as this is the type of condition which may lead to a fatality if untreated.

This study is based on 107 cases from 3 sources of material. First, bed-side x-ray examinations were done on an unselected group of postoperative cases on the first day following surgery and every subsequent day through the fifth. If gas appeared in the small bowel during this period films were taken daily until the gas disappeared. If the patient had any abdominal distress, films were taken daily until the patient felt well.

The second group in this series comprised all those patients who entered the hospital with distention and a questionable diagnosis of bowel obstruction. This group offered a valuable opportunity to test the accuracy of the diagnosis, because most of these patients went to surgery within a few hours so that it was possible for us to compare the appearance of the bowel on the x-ray film with that found at surgery. This is most important. If we are to learn anything at all about x-ray appearance of the bowel, we must have confirmation as soon as possible after the film is taken. Conditions change rapidly in the abdomen with bowel obstruction. From hour to hour, the x-ray findings and the clinical picture may change. In comparatively short time, a simple mechanical bowel obstruction may terminate in peritonitis with a paralytic ileus. Obviously, comparing a film to what may be found at surgery a day or two later or comparing a film to the findings of a postmortem examination days or weeks later will lead to erroneous conclusions with reference to the accuracy of the x-ray interpretation.

The third group of cases are those in which postoperative symptoms appeared of such a nature as to warrant x-ray investigations for a suspected bowel obstruction.

GROUP I. UNSELECTED CASES STUDIED AFTER OPERATION

In all, 20 patients were studied by x-ray examination of the abdomen after operation. The type of operation varied: they were all abdominal except for one which was a repair of an inguinal hernia. The operations were performed by 7 surgeons, so no one operator can be blamed for "rough handling" of the bowel. While this group is too small from which to draw conclusions, certain impressions do stand out.

First, irrespective of age or type of surgery, distended bowel of a paralytic nature followed abdominal surgery in 15 of the 20 cases, or 75 per cent. All of these patients but one complained of "gas pains." This one case showed only a mild distention of the bowel by x-ray. In other words, all patients who complained of gas pains, had x-ray evidence of distention. In 3 cases without x-ray evidence of distention, there was no discomfort on the part of the patient. Every patient complaining of distention and pain after operation is a potential case of mechanical bowel obstruction. A differential diagnosis between mechanical obstruction and paralytic ileus can be made by x-ray examination, as here mentioned. The x-ray findings of distention usually appeared on the first postoperative day except in 1 patient in whom the gas did not appear on the film until the third day. The distention usually lasted 3 days. It is of interest to note that the complaints of the patient did not occur with the appearance of gas in the bowel as found on the film but followed a day or two later. This raises a question. Is the pain due to peristalsis attempting to overcome the distention rather than distress from the distention itself?

Second, the type of anesthesia seemed to play no part. Subarachnoid, avertin, cyclopropane, ether, novocain were all employed. At times one agent was used, in other cases two were used in combination: subarachnoid-ether, subarachnoid-cyclopropane, avertin-cyclopropane. No one type of anesthesia or combination of agents showed more or less distention.

Two cases in this series called our attention to a fact which to our knowledge has never been mentioned in the literature. These 2 patients had few or no symptoms after operation and under ordinary circumstances would have been regarded as following the usual postoperative course. However, the postoperative x-ray examination showed a low mechanical bowel obstruction. This was early in our work, and in view of the clinical well-being of both the patients showing no clinical evidence of obstruction, with normal temperature

and pulse rate, the x-ray findings were disregarded.

The first case was a woman, aged 69 years, who entered the hospital with a strangulated femoral hernia. Her condition at surgery was so poor that it was decided to chance a return of viability of the strangulated bowel after it was freed rather than proceed with a resection. For the first 3 days after operation she had moderate discomfort, following which she felt well and her general condition improved. Yet consecutive x-ray films showed continued evidence of a mechanical obstruction. On the 11th postoperative day the patient's condition suddenly became poor. There was a rise in pulse rate, respirations increased, and she had nausea and vomiting. A Miller-Abbott tube was passed and the distressing symptoms were almost immediately relieved. Likewise, the x-ray evidence of small bowel distention was gone.

The second case was one in which an appendectomy had been performed.

The appendix was ruptured and lying in an anomalous position beneath a band of mesentery. There were also congenital bands in the pelvis. Films were taken immediately following surgery. The patient felt well but the x-ray films demonstrated a mechanical obstruction. Again, the x-ray findings were disregarded in view of the absence of clinical symptoms of obstruction. The patient continued to feel well up to the 12th day after operation. On this day he complained of abdominal pain; there was a rise in pulse rate and temperature. The abdomen was not distended but the x-ray film showed a persistent evidence of mechanical obstruction. Wangensteen suction was unsuccessful. On the 18th postoperative day, he was again operated upon and a mechanical obstruction due to a band was found. An enteroenterostomy was performed to relieve the distention. X-ray films taken after the second operation showed no evidence of a block. He made an uneventful recovery.

Both of these cases showed a mechanical obstruction by x-ray immediately following surgery. The patients experienced no discomfort nor any symptoms indicating bowel obstruction, which must have been partial as there were bowel movements. Why the distention went as far as the 10th to 12th day without symptoms and why the sudden collapse of the patients are questions that we are not prepared to answer at this time. It is not the block itself. In 3 cases not included in this group, where bowel resection was carried out, follow-up x-ray examination showed distention of a mechanical nature proximal to the anastomosis for 5 days in 2 cases and 7 days in the other. The distention was due to the edema along the suture line of the anastomosis causing a partial obstruction. No clinical symptoms of obstruction were present at any time. Wangensteen has shown that if the bowel is kept deflated by intubation and the body fluids and chlorides maintained to their normal levels, patients can live in spite of bowel obstruction. The 2 patients mentioned did not have the distention to the extent of causing a pressure necrosis with gangrene of the bowel. The turn of symptoms was sudden. If we do not consider the block with absorption of toxins as the factor, we may consider the neurogenic factor, as advanced by Antoncic and Lawson. Working on experimental denervated closed loops of intestine, they concluded that the sudden collapse was due to afferent impulses from the distended viscus which caused vomiting with fall of pressure. Sudden collapse was not due to any specific toxin. Whatever the cause, it is sufficient to recognize the fact that a mechanical small bowel distention can exist without symptoms. It should be deflated as soon as diagnosed and treatment should not be withheld until symptoms of collapse appear.

GROUP II. CASES ENTERING HOSPITAL WITH ABDOMINAL DISTENTION AND SUSPECTED BOWEL OBSTRUCTION

This was the largest group, consisting of 65 cases. Some of these patients went to surgery and gave us the opportunity to check the accuracy of our findings. The diagnosis of mechanical obstruction was made in 30 cases. Twenty-nine of these were operated upon within the subsequent 12 hours. The causes of the obstruction were found at surgery to be: adhesions from previous operations, 5; large bowel block by cancer with back pressure into the small bowel, 5; volvulus, 4; carcinoma implants, 3; appendiceal abscesses, 3; internal hernia, 3; ileocolic intussusception, 2; intussusception of Meckel's diverticulum, 1; gall stone impacted at terminal ileum, 1; perforated bladder with adherent small bowel, 1; mesenteric adenitis with glands in right lower quadrant, 1.

The one case in this series which did not go to surgery had negative x-ray findings the following day and the patient was free of symptoms. However, this does not completely rule out the diagnosis of mechanical obstruction. Very fine adhesive bands causing an obstruction may later free themselves. A volvulus may untwist or a hernia may reduce itself. Therefore, it is not too much to assume that in this case the obstruction relieved itself, as shown by the subsequent negative x-ray findings.

Seven cases of this group were diagnosed on entry as paralytic ileus. Six of these went to surgery and the findings were: acute appendicitis, 2; perforated duodenal ulcer, 1; inguinal hernia, 1; bleeding follicular cyst, 1; mesenteric thrombosis with gangrenous lower ileum, 1. In none of these cases was a mechanical obstruction found. As pointed out, paralytic ileus can be caused by any reflex affecting the autonomic nervous system. The finding of paralytic ileus in these cases was not incompatible with the pathological condition found at surgery.

In 7 other cases, there were no x-ray findings of either paralytic ileus or mechanical obstruction, but there was sufficient clinical evidence to warrant surgery. At surgery, no mechanical obstruction was found in any of the cases. The findings at surgery were: gangrenous appendicitis, 1; empyema of gall bladder, 1; gangrenous gall bladder with stones, 1; mesenteric adenitis, 1; perforated duodenal ulcer, 2; femoral hernia with fat and omentum in sac, 1.

The absence of x-ray findings of distention does not rule out a severe bowel pathological lesion. Especially is this true in cases of strangulated bowel, which differ in their x-ray findings from other types of bowel obstruction. In any of the above cases, gas is found to be accumulating above the obstruction. This is not true of strangulated bowel; here, gas is never found in the strangulated loop and is not seen proximal to the obstructing loop. Brunn (personal communication) has made this observation in 4 cases. In 1 case, operation was delayed for 24 hours because the x-ray findings were consistently negative. Groper reported a case of volvulus resulting in gangrene of the bowel. There was no gas either in the loop of gangrenous bowel or in the loop proximal to it. To be re-emphasized is the fact that absence of gas in the bowel does not exclude a severe degree of strangulated obstruction. It is the positive findings of gas in the small bowel that we wish to stress.

The 22 remaining cases of this group had no x-ray evidence of distention, either mechanical or paralytic. They were discharged from the hospital within a few days to a week without surgery and the follow-up in all instances has shown them to be well.

To summarize the cases of group II: all cases diagnosed as mechanical obstruction by x-ray in which patients came to surgery, had the diagnosis confirmed. The 2 patients who were not operated upon had normal x-ray findings the next day. Those cases diagnosed as paralytic ileus, in which patients came to surgery, showed a pathological condition which could cause paralytic ileus but not necessarily cause a mechanical block. In other words, mechanical obstruction was found only in those cases so diagnosed. Seven patients who did not show bowel distention by x-ray but came to surgery because of other clinical evidence had no bowel obstruction at the operating table. On the other hand, negative x-ray findings of either mechanical or paralytic distention does not imply the absence of severe strangulated obstruction. The diagnosis in this instance must be made from the clinical symptoms.

GROUP III. CASES OF POSTOPERATIVE DISTENTION NOT INCLUDED IN GROUP I.

Group III consisted of those patients who had postoperative distention of such a nature as to require x-ray examination to aid in the diagnosis. This is an additional postoperative study not included in the first group and consisted of 22 cases. In 15 cases in this group patients had evidence of mechanical bowel obstruction. Six of these came to surgery and the following was found: band following removal of pancreatic cyst, 1; abscess following appendectomy with adherent small bowel, 1; colostomy-loop caught behind colostomy, 1; colostomy-loop distended before opening, 1; adhesions not cut in previous operations, 2. Eight patients were relieved by the Miller-Abbott tube and 1 died. At autopsy a thin band adhesion was found. The 7 remaining cases were diagnosed as paralytic ileus and all patients recovered without further investigation.

From this analysis we do not wish to imply that all cases of the abdomen examined by x-ray will fall into 1 of the 3 groups, either mechanical obstruction, paralytic ileus or no distention. What we have endeavored to stress is that a differential diagnosis can be made. There are instances of distention of the bowel which may resemble either one or be mixed, and other cases which cannot be diagnosed. Levitin (5) has found a regional paralytic ileus neighboring a localized intra-abdominal abscess or an acute inflammatory process. In turn, this local ileus may act as a point of block and result in a mechanical obstruction proximal to this point. In this instance there is a combination of local ileus and mechanical block. Levitin (6) also noted a local distention in an intussusception, one case resulting in a mechanical block to the proximal bowel.

A confusing abdominal picture is that of a mechanical obstruction of the colon with back pressure into the small bowel resulting in a small bowel distention. The mechanical block is usually due to a carcinoma of the colon. Here we have distention of the small and large bowel of the same relative degree which fits the criteria of paralytic ileus, yet it is a mechanical block. If the film in this instance is carefully observed, it will be noted that the distention in the colon ends abruptly, with no gas in the rectum. But even this may not be too evident. If in doubt, it is best to give a barium enema. This can be carried out without harm to the patient. In all instances, the history is most important and at all times has to be correlated with the x-ray findings.

In another instance of block in the transverse colon, only a segment of the colon was distended

proximal to the obstruction. This may be confused with a single loop of small bowel distention, as the haustral markings can be confused with valvulae conniventes of the small bowel. Films taken at intervals with the patient in different positions showed this gas to pass back into the cecum, so that the gas was located in the colon and the nature of the obstruction determined. We have also found distention of the small and large bowel simulating a large bowel obstruction in a case of circulatory failure. Again the history of the case will often be the deciding factor in the diagnosis.

We cannot stress too much the importance of correlating the x-ray findings with the history and clinical findings. X-ray films of the distended abdomen cannot be diagnosed the next day in the usual routine reading of films. The reading cannot be left to the house staff. It is an emergency procedure which requires the consultation of the roentgenologist with the clinician at the time the film is taken. It is only in this way that the x-ray findings can be intelligently interpreted.

No discussion of bowel obstruction can be complete without mention of the Miller-Abbott tube in therapy. When judiciously used, it may relieve the distention and surgery may not be necessary; or it will deflate the bowel, facilitating handling at surgery. However, there is a limitation to the usefulness of this tube. It takes a few hours to introduce the tube into the small bowel. Very often it fails to get into the duodenum. A good deal of time and patience are required. This delay may be disastrous to the patient, as we have found that a low mechanical obstruction may be present for days without causing symptoms severe enough to bring the patient to the hospital. The history of such a patient is often that of discomfort or distention 2 to 3 days before seen by the physician. We do not know how long an obstruction has existed before symptoms became manifest. The x-ray does not tell us the state of viability of the bowel and too often gangrene is later found to be present. For the patient entering the hospital with a low mechanical obstruction, we do not recommend the use of the tube. The patient with postoperative distention presents a different problem. The obstruction is often due to a thin fibrin band which may easily be broken. The time interval is known; it is safe to delay surgery and attempt to pass the tube. In all, 8 patients with postoperative distention were successfully treated by this method.

CONCLUSIONS

1. X-ray findings in abdominal distention are significant and are important in differentiating paralytic ileus from mechanical obstruction.

2. Postoperative distention is usually in the nature of paralytic ileus which appears 1 to 3 days after operation, lasts about 2 to 3 days or longer, and usually clears spontaneously without incident.

3. Type of anesthesia does not seem to influence the production or prevention of postoperative paralytic ileus.

4. Mechanical block may exist without clinical manifestations. When treated surgically, the bowel returns to normal almost immediately, as viewed in the x-ray film.

5. A positive x-ray diagnosis of mechanical obstruction is definite evidence regardless of the presence or absence of clinical symptoms.

6. Negative x-ray findings in a clinically distended abdomen do not rule out the presence of severe abdominal pathology.

7. The Miller-Abbott tube plays a definite rôle in the therapy of bowel obstruction but has its limitations.

REFERENCES

1. Antoncic, R. F., and Lawson, H. Surg. Gyn. Obst., 1941, 72: 728–731.
2. Brunn, H., and Levitin, J. Surg. Gyn. Obst., 1940, 70: 914–921.
3. Devine, Sir Hugh. The Surgery of the Alimentary Tract. Baltimore: Williams & Wilkins Co., 1940.
4. Groper, M. J. Ann. Surg., 1940. 112: 344–351.
5. Levitin, J. Radiology, 1941, 37: 205–207.
6. Idem. Am. J. Surg., 1941, 54: 494–498.
7. Idem. Small Bowel Distension: Differential Diagnosis of Mechanical Obstruction and Paralytic Ileus by means of X-Ray examination. Medico-Surgical Tributes to Harold Brunn. Berkeley: University of California Press, 1942.
8. Ochsner, A. Am. J. Roentg., 1937, 37: 433–445.
9. Wangensteen, O. H. The Therapeutic Problem in Bowel Obstruction. Springfield, Ill.: C. C. Thomas, 1937.

VITAMIN E IN THE PROPHYLAXIS OF ABRUPTIO PLACENTAE

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FOR years abruptio placentae has been defined as the premature separation of all or a large portion of the normally implanted placenta. This occurs suddenly, often on the basis of a late pregnancy toxemia, and is characterized by uterine pain and tenderness, bleeding, and even shock. Because the onset of this severe condition is held to be catastrophic, it is necessarily unforeseen. Therefore, the counter measures advised tend to be radical, with results which are not always happy for the mother and certainly not for the child. In this deplorable state of affairs it is obvious that premonitory signs and symptoms, if there be such, should be sought.

In 1937 the author (3, 4) called attention to the significance of the very common small areas of uterine tenderness complained of even in early pregnancies, and advanced reasons for ascribing the development of these to small placental detachments. If, as is the case, these areas of localized tenderness are often associated with traces of small retroplacental hemorrhages when the placenta comes to inspection, there is no good reason why the use of the term abruptio should be restricted to the more extensive subplacental hemorrhages only. Should we take eclampsia and pre-eclampsia for an analogy, these early, small, tender placental detachments might be referred to as pre-abruptios, and be the very phenomena to be recognized in the anticipation and prophylaxis of the major catastrophes. One suspects that McKelvey refers to these when he speaks of "miniature premature separations." Although he claims they produce "no clinical symptoms" he adds that they offer "the best available material for the study of the mechanism of premature separation. Larger hemorrhages lead to clinical premature separation." He finds evidence to suggest that "the basic circumstances inherent in premature separation of the placenta are present in most, if not all, human placentas." We think that the mild abruptios are very common.

Even in a small series of pregnancies, women are found having areas of uterine tenderness of all degrees of severity, and these women may bleed extensively, only a little, or not at all. These tender areas may disappear, only to recur one or many times in the same pregnancy. ***But they always recur at the same place on the uterine wall,*** and on a few occasions this has been demonstrated to be actually the placental site (4). If the first tenderness is untreated or inadequately treated its later phases or recurrences are often accompanied by toxemia. Sometimes, but not always, such a woman goes on to the development of a characteristic and conventional abruptio placentae. Some of the appended case histories illustrate this. However, this disastrous sequence need not always follow, as will be explained later.

There is no good reason why a dogmatic and entirely artificial line should be drawn, on one side of which lie women exhibiting only small areas of uterine pain and tenderness, with or without "spotting" or hemorrhage, and with only such early evidences of toxemia as excessive weight gain or blood pressures on the high side of "normal." On the other side we traditionally have put the placental catastrophes, usually having great and extensive tenderness and pain or shock, slight or marked hemorrhage, and severe toxemia. Moreover, the typical pathological picture of the placenta in abruptio placentae is not confined to placentas expelled in the last trimester of pregnancy. It has been seen by every obstetrician in the placentae of simple miscarriages and even may be recognized in the decidua basalis of spontaneous abortions. Perhaps for that reason, De Lee has said picturesquely that an abruptio is merely an "abortion at or near term." The converse is equally true, of course, namely that the placenta in even the most typical clinical case of abruptio at term or near it may display nothing to substantiate the clinical diagnosis.

Obstetricians have too generally ignored the small, discrete areas of uterine tenderness here referred to. These have been summarily dismissed as "adhesions," "the baby kicking," "stretching," or even, when severe and in the right lower quadrant, as "appendicitis." The writer has seen a number of these "appendicitis" cases in consultation—on 2 occasions after the appendix had been removed (1 of these in the physician's wife mentioned in Case 3)! The differential diagnosis is usually very simple, if it

be remembered that appendiceal tenderness in pregnancy is parauterine but the tenderness due to placental detachment is uterine.

RELATION TO VITAMIN E DEFICIENCY

Quite early in his studies on vitamin E deficiency it became apparent to the writer (5) that uterine tenderness was almost always the first sign of vitamin E deficiency in human pregnancy, that it could *always* be relieved by the prompt administration of enough vitamin E, and that if it recurred it was evidence of escape from vitamin E control. As extensive blood studies of the vitamin E estrogen equilibrium were continued it was seen that, like spontaneous abortion, abruptio placentae of either the classical degree of severity or of the mild degree described here was usually associated with vitamin E deficiency and its concomitant estrogen excess. Of course, abruptio placentae of the most typical sort can occur in the absence of any one of its major criteria, viz.: pain, tenderness, shock, external hemorrhage, toxemia, or a high blood estrogen value. When blood studies in early pregnancy revealed this vitamin E estrogen imbalance, it was at once anticipated (6) that somewhere in the future of that pregnancy lay an abortion, miscarriage, premature delivery, noneclamptic toxemia, abruptio placentae, or anomalous child. Much the same idea suggested to Young the useful and graphic concept of the "abortion sequence." The point to be stressed is that the danger of abruptio placentae, classical or mild, can almost always be foreseen, and, as what follows may indicate, can usually be prevented. The appended case reports are intended to illustrate that: (a) The first clinical sign of placental detachment is a localized area of uterine tenderness, with or without slight bleeding or slight toxemia. (b) Abruptio placentae can often be foreseen even earlier in pregnancy by means of a blood estrogen assay (7). Such an assay is a *sine qua non* for its early recognition. (c) If the early signs are neglected the patient may go on to display classical abruptio placentae. (d) The early phenomena disappear promptly if enough vitamin E is administered at once. (e) The vitamin E used must be a potent preparation. The dose usually rises as pregnancy proceeds and must always be the dose required to control symptoms in that particular woman's pregnancy, not just a standard dose. It must be given until delivery.

CASE HISTORIES

CASE 1. This patient, a physician's wife, aged 27 years, had had a spontaneous abortion, in 1934. In 1935 she conceived again, her last menses coming May 8. Her blood estrogen was positive on October 8. On November 30 she suddenly developed severe labor pains, lasting for 7 hours. They subsided after large doses of wheat germ oil. She was kept on a small dose thenceforth. On January 1, 1936, she suddenly awakened, crying, with a "tearing pain" in her right lower quadrant, violent fetal movements, and acute uterine tenderness on the lower right aspect. Her uterus had the characteristic ligneous consistency. Her blood estrogen was still high, and we found that the wheat germ oil capsules she had been taking were old and therefore deteriorated. She was given large doses of a fresh, bulk, wheat germ oil on January 2, and the ligneous consistency of the uterus disappeared by nightfall. Her blood pressure then was 118/80 and there was no albuminuria, but the tenderness and pain remained about the same.

She was much better by the 4th but it was decided to induce labor, as this was the first case of this degree of severity that we had attempted to handle with vitamin E. The membranes were ruptured artifically at 2.00 P.M. and a pinkish, greenish amniotic fluid escaped. Strong pains soon began, and all night she had tremendous uterine contractions and pain. No cervical dilatation ensued, she became exhausted, and, after a consultation at 6.00 A.M. on the 5th, cesarean section was decided on.

When the abdomen was opened 2 hematomas 2 centimeters in diameter were found on the anterior aspect of the uterus near the white line. When the anterior flap of visceral peritoneum was elevated and was gently dissected off with the finger, small hematomas appeared wherever the uterine wall was touched. When the lower segment was picked up with Allis forceps it tore like butter. A 6 pound 10 ounce girl in fair condition was finally extracted. The uterine wall was very hard to close; sutures would scarcely hold on account of its extreme friability. The patient had some pyelitis on the 4th day postpartum. Otherwise her convalescence was uneventful and the child has been normal since. There have been no further pregnancies.

CASE 2. This woman, a professor's wife, aged 30 years, had had a girl and boy before, the latter pregnancy uneventful and under my care. With her third pregnancy the last menstruation began on April 28, 1936. Her blood estrogen was positive when she was first seen on June 9, her blood pressure 130/74, her weight 132 pounds, and her urine clear. She was promptly put on a bulk wheat germ oil preparation. There was vomiting in early pregnancy. On August 4 she complained that her abdomen felt all the time "as if it had been kicked." Her weight then was 135 and her pressure 130/64. When seen on September 1 she mentioned that she had had severe, palpable, uterine contractions for the preceding 10 days, with sacral backache but no bleeding. She was given big doses of the wheat germ oil but it had no effect. We found that no precautions as to its freshness and refrigeration had been taken. Accordingly she was given Kelly's oil beginning on the 17th, 2 tablespoons per day. The uterine cramps ceased, although considerable diffuse uterine tenderness persisted. Her pubic symphysis became tender and locomotion correspondingly difficult. Her blood pressure, weight, and urine remained normal. On January 11 she took castor oil and quinine, nearly precipitating, in 1½ hours' time, dichorionic female twins of 6 pounds and 5 pounds, respectively. The placentas each showed a small, old, marginal infarct on the maternal aspect, about 2 centimeters in diameter. Mother and twins did well.

CASE 3. This physician's wife, aged 27 years, a primipara, menstruated last on September 9, 1936. I first saw her on January 17, 1937. She gave a history of appendectomy on October 15 with the removal of a normal appendix. As her "appendicitis" was left-sided as well as right-sided before the operation, she had asked her surgeon to explore

the left as well as the right side of her abdomen! Her pain continued after operation just as before.

When she was first seen she was 4½ lunar months' pregnant, had felt life 3 days before, had a definitely tender area near the right cornu, had a blood pressure of 136/84, and a negative estrogen test. She had bled a few drops on November 8 after a motor trip.

In spite of the blood test she was put on Kelly's wheat germ oil throughout her pregnancy. She had an idiosyncrasy to it and promptly developed an itchy rash, but it was felt that she dare not discontinue it. There were attacks of cholecystitis also. On April 27 her pressure had risen to 150/92, and her weight was 170 pounds. There was no albuminuria at any time. She was raised to a tablespoon of oil per day. She soon felt "like 100 in the shade" all the time, due to her idiosyncrasy to the oil, and her rash became very troublesome. The urine remained normal but some edema developed, her weight soon rose to 175, and on May 7 her blood pressure was still 140/94, where it remained. Labor began spontaneously on June 7, 1937. A short labor produced a normal 7 pound girl. The placenta came in 30 minutes, and showed four marginal, deep, white infarcts ranging in size from 1 to 3 centimeters in diameter. Mother and child did well.

She has had one uneventful pregnancy since.

CASE 4. This woman, aged 35 years, a primipara, was first seen on January 10, 1939. Her last menses had begun on October 4, 1938. At her first visit her blood pressure was 130/78, weight 140 pounds, and blood estrogen positive. Accordingly she was at once given Kelly's wheat germ oil. She went along uneventfully until on May 11 it was noticed how unusually tense the uterine wall was. At that time her weight was 151, her pressure 130/76. There was no albuminuria and the position of the child could not be made out although she was about 7½ lunar months' size. She bled about a cupful of bright red blood on May 27, was tender at the right lower aspect of the uterus, and her daily dessertspoon of oil was increased to 2 tablespoons. There was no more bleeding during the pregnancy, but one never was able to outline the baby as the uterine wall remained too tense. Three days before her labor began on June 25, 1939, her weight was 154, blood pressure 134/70, and the urine clear. She delivered on June 25, with the help of low forceps for a deep transverse arrest, a 6 pound 10 ounce boy. The uterus was tense throughout labor. The placenta seemed completely normal. There was no excess of amniotic fluid. Mother and child did well thereafter.

CASE 5. This woman, aged 28 years, a primipara, menstruated last on July 25, 1939. She was first seen on October 24, 1939, when 3 months' pregnant. Her blood estrogen was positive, and she was therefore given Kelly's wheat germ oil. Her blood pressure was 112/56 and her weight 121 pounds. After she felt life she stopped taking the oil, unknown to me. She had an uneventful pregnancy except for some sciatica and cholecystitis. On April 25 her weight was 135 pounds, her blood pressure 112/66 and her abdomen was "huge," according to my notes. She took castor oil on her own initiative on May 1 and felt no life thereafter. Three days later she had a "tearing pain worse than a labor" and on the 6th she delivered a slightly macerated female child at term. The placenta was normal except for two small, marginal, old white infarcts. The amniotic fluid was pink. Autopsy on the child was uninformative.

She became pregnant again in 1941. Her last period began on December 23. Her blood estrogen was positive again, and once more she was given Kelly's wheat germ oil and warned to continue it until term. Her pregnancy was uneventful except for a recurrence of her sciatica. Her initial weight was 117 pounds, and blood pressure 84/60. On September 30 these were 141 and 96/66, respectively. There was no albuminuria. Labor was induced on October 5 when she was 6 days over her due date. When the membranes were ruptured the amniotic fluid was blood-tinged again. An 8 pound boy was delivered in fine condition after a 5 hour labor. The placenta was normal.

CASE 6. This patient, aged 32 years, had had two normal pregnancies before. Her last period came on December 31, 1940. She was first seen on May 8, 1941, at which time her blood estrogen was negative, her weight 152 pounds, and blood pressure 114/70. She had an uneventful course until August 2, when she felt as if labor was impending and accordingly was given 1 teaspoon of Kelly's wheat germ oil daily. She then weighed 160, and her blood pressure was 120/76. As she began to have uterine cramps, her dosage was soon raised to 2 teaspoons per day. She felt vaguely ill for the next month, her weight on September 25 being 170 pounds and her blood pressure 138/84. Her urine was clear throughout. There was no edema. On October 3 she began labor spontaneously. She ruptured her membranes on the 4th and lost bloody amniotic fluid. Her pains were only moderate and a mid-forceps was finally done. The child weighed 9 pounds 7 ounces, had a bilateral hair-lip and a severe cleft palate. The shoulders were extremely difficult and the left humerus was fractured in their extraction. The placenta came easily and was normal in appearance.

CASE 7. This woman, aged 38 years, had had an induced abortion, then two toxic pregnancies proceeding to term, and then another induced abortion by her first marriage. The last of these was in 1936. She was married the second time in 1940. Her last period in this pregnancy began January 28, 1941. She was first seen on May 1, with a weight of 135 pounds and blood pressure of 98/68. Her blood estrogen was positive. She had severe uterine cramps on May 20 and was given Kelly's wheat germ oil at once. She spontaneously ruptured her membranes on June 11 and complained of uterine pains, but did not go into labor. At that time she had a moderate degree of edema, and a blood pressure of 128/88. Henceforth she was carried along on at least 1 tablespoonful of the oil per day. On June 28 her weight had fallen to 140 pounds, her pressure to 114/76, and there was less edema. The child was active. She was kept in bed for the first 16 days of July because of uterine contractions occurring in spite of 4 tablespoons of the oil per day. Afterward her weight was 153, pressure 130/90, and her leg edema was only trivial. She was now taking 3 ounces of oil per day. On October 11 she tried hard to go into labor, had considerable leg and hand edema, had a blood pressure of 126/84, and was given 50 milligrams of ephynal per day henceforth instead of further wheat germ oil.

On November 1 she went into labor spontaneously with a sudden violent hemorrhage. When sent to hospital she continued to ooze blood slowly. The uterus was too tense to palpate. X-ray films showed a breech presentation with the child in tight flexion. A vaginal examination showed no placenta previa and that the membranes were intact. She was allowed to labor in the Trendelenburg position because, otherwise, the fetal heart tones slowed down and almost stopped with each contraction of the uterus. Another vaginal examination revealed no cord prolapse that was palpable. The bleeding continued steadily, and considering everything, a low cervical cesarean section was decided upon. The girl delivered weighed 4 pounds 6 ounces and was in poor condition for several days. At operation the placenta was forcibly ejected out of the wound as if the uterus had spit it out. There were huge clots behind it. We had apparently barely beaten a complete detachment. The child died of pneumonia when 5 weeks old, unfortunately. The mother has done well.

CASE 8. This woman was a physician's wife, aged 27 years. I had attended her in an uneventful first pregnancy in 1938. Her last period in this pregnancy began April 13, 1941. She had a negative blood estrogen assay on May 22. As there was considerable vomiting she was given 0.2 milligram ovocylin per day, and on this there was only slight nausea but no vomiting. Every time the estrogen was discontinued, her vomiting recurred, until she had attained her 4th month.

On September 9 she developed pain and severe tenderness in both lower quadrants of the uterus. She was accordingly given 30 milligrams of ephynal per day for 2 days, then carried on 9 milligrams per day after the 11th. She bled moderately on the 13th but thereafter the tenderness soon subsided, and she never bled again. On November 15 she reported that the pain had recurred in the right lower quadrant of the uterus. Her blood pressure then was 118/64, and there was no albuminuria. Her dose was raised to 40 milligrams per day. On December 13 strong "labor pains" occurred and lasted throughout the night. Her blood pressure was 112/70, there was no bleeding and no edema, but the uterine tender area had reappeared. She was raised to 75 milligrams of ephynal per day, which kept her well and symptom-free until December 27 when it was necessary to raise her dose to 100 milligrams per day to relieve her severe pain. She again had freedom from distress until January 9 when it was raised to 125 milligrams per day. This did not give complete relief and she became dizzy. She therefore refused to take more than 100 milligrams thereafter. There was no albuminuria throughout pregnancy. On January 14 her labor began spontaneously, was characterized by very severe contractions, and was over in 2½ hours, she being delivered of a fine 7 pound, 2 ounce boy. (Her first boy had weighed 8 pounds 6 ounces, be it noted.) The placenta was expelled immediately and displayed at one margin a typical area of recent abruptio 2 inches in diameter. There was an easy convalescence of both mother and child.

CASE 9. This woman, aged 26 years, had had no pregnancies before. Her last period began May 24, 1941. She was first seen on July 4, 1941, when her blood estrogen was positive, her weight 134 pounds, her blood pressure, 90/60. She was put on Kelly's wheat germ oil at once, but was unable to take it, so was given ephynal. On the 18th she reported a sensation of impending menstruation and that she had had typical menstrual distress 2 nights before. Her dose was therefore raised to 30 milligrams per day.

She was well until November 28, at which time her blood pressure had increased to 136/64, her weight to 154 pounds, and there was minimal leg edema. For 2 days she had severe cramps as if going into labor. She had dropped her ephynal dosage to 10 milligrams per day before this, but now reverted to 30 milligrams. On December 16 she bled and had severe pains. She was given 70 milligrams for 2 days, and put to bed. This attack subsided promptly. On the 26th her pressure had risen to 128/86. Her continuing dose was then put at 40 milligrams of ephynal. She suffered another bout of pain on December 31, so her dose was raised to 50 milligrams. On January 18, she had severe cramps again but no bleeding. There was no albuminuria at any time.

Labor was artificially induced 2 days before her due date and she readily delivered a 4 pound 7 ounce boy after a 7 hour labor. The placenta looked normal except for streaks of old black blood on the maternal aspect near one margin. This margin must have separated early in labor or even before.

The mild types of abruptio described above do not always go on to the severest grade because all high estrin phenomena tend to be self-limiting, probably by anterior pituitary inhibition. If the production of follicle-ripening gonadotrophic hormone in the anterior pituitary is thus slowed down, the blood estrogen level probably soon falls to more normal levels—at least in early pregnancy, when the placenta is a very secondary hormone source. Hence threatened abortions, threatened miscarriages, threatened premature labors, and mild abruptios tend to subside spontaneously but also to recur; often they may appear to be controlled fairly satisfactorily by the simplest measures, such as bed rest, for example.

Our results could undoubtedly have been improved by the use of larger doses of vitamin E administered earlier in pregnancy. As these were all private patients, economic considerations could not be overlooked, however. The smallest dose was used that seemed likely to relieve symptoms; we used no more until forced to do so. It should be unnecessary nowadays to stress the importance of using a potent preparation of vitamin E. Many products now on the market are far from satisfactory in this respect, however.

It is extremely difficult or impossible to select clinical histories to prove beyond dispute that vitamin E prevents the development of the classical sort of abruptio placentae. If its intensive use prevents the appearance of such cases, there is no proof that the patients so treated would otherwise have developed abruptio. If abruptio develops on proper vitamin E therapy, then vitamin E is valueless. The cases reported here were held so close to the brink that anyone can still recognize them as abruptios, but it is hoped that it is equally clear that some amelioration of their condition can be ascribed justly to the medication used prophylactically, viz., vitamin E. Better controlled patients might have been described, but the clinical diagnosis would have been criticized sharply. Somewhat analogously, one can, perhaps, suspect from animal experimentation that elevated estrogen levels in the body over a period of years may eventuate in fibroids in women and prostatic hypertrophy in men, but to demonstrate these theses beyond dispute is quite another matter, and may never be possible. An adequately controlled series of thousands of patients would take years to collect, for the severest abruptios are not encountered every day. Such a series was actually being prepared in Canada before the war, but that study lapsed when the obstetrician involved enlisted.

There are probably insuperable difficulties to animal experimentation on this problem, since the placentae of man and animals differ so greatly.

However, hemorrhage into the amniotic cavity characteristically marks the onset of the termination of pregnancy and the death of the fetuses in vitamin E defective rats (9). This develops on the 12th day, in the second third of such pregnancies—one can scarcely say second trimester, but there may be a human analogy here.

No pregnant uterus should be tender, and the search for tender areas should be as prominent a feature of antenatal care as the supervision of blood pressure and weight. No one would think of administering vitamin E to one of the classical, maximally severe abruptios. How it could help a patient whose placenta is already separated completely or in large part is hard to imagine. But, as has been indicated, the blood estrogen levels of such patients indicate that they display the same estrogen E imbalance as is seen in the milder examples of uterine tenderness and bleeding. One suspects that the classical abruptios are merely the big brothers of the latter who have been allowed to run wild but should all bear the family's surname, abruptio.

The author has been quoted widely in the trade literature on the value of vitamin E in the treatment of abruptio placentae, and does not object if the specific meaning he attaches to the term be kept in mind. Indeed, in order to clarify this very point it was stated in a footnote to one of his papers that the statistics and conclusions in it were not confined to abruptio cases in which the term was used only in the textbook sense of the word.

The writer has given large doses of estrogens to convulsive eclamptics a number of times. On 2 occasions abruptio placentae has quickly ensued (8) with profuse hemorrhage and severe pains. This is another illustration of the relationship of high estrogen levels to the onset of abruptio placentae in late pregnancy.

SUMMARY

1. Abruptio placentae is a late stage of a condition usually recognizable in its early phases by the appearance of small areas of uterine tenderness, small uterine hemorrhages, and evidences of incipient toxemia.

2. It is characterized by a disturbance of the relationship between vitamin E and the estrogens. This can be recognized very early in pregnancy, and on this point hangs the prophylaxis of major catastrophes of this type.

3. The prophylactic value of vitamin E, administered continuously, and in increasing doses as term approaches or frank evidences of toxemia show themselves, is discussed. Illustrative case histories are presented.

4. It is suggested that the best therapy of abruptio placentae is its prevention, and that that is now possible.

REFERENCES

1. De Lee, J. B. The Principles and Practice of Obstetrics. 7th ed., p. 499. Philadelphia and London: W. B. Saunders Co., 1938.
2. McKelvey, J. L. Am. J. Obst., 1939, 38: 815.
3. Shute, E. V. J. Obst. Gyn. Brit. Empire, 1937, 44: 121.
4. Idem. Am. J. Obst., 1937, 33: 429.
5. Idem. J. Obst. Gyn. Brit. Empire, 1936, 43: 74.
6. Ibid. 1937, 44: 253.
7. Idem. Am. J. Obst., 1938, 35: 609.
8. Idem. Endocrinology, 1937, 21: 594.
9. Urner, J. A. Anat. Rec., 1931, 50: 175.
10. Young, J. Brit. M. J., 1937, 1: 953.

EDITORIALS

SURGERY
Gynecology and Obstetrics

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OCTOBER, 1942

ANNOUNCEMENT

Dr. Frederick Christopher will act for the Editor during the period in which Dr. Davis will serve in the armed forces. Dr. Christopher is a graduate of Johns Hopkins University School of Medicine, associate professor of surgery at Northwestern University Medical School, surgeon in chief of the Evanston Hospital, and the author of one and editor of another of the best known texts on surgery.

The policies of this journal will remain unchanged and all communications should be addressed to the Editor as in the past.

THE SURGICAL DIABETIC

IT is estimated that one and one-half to two per cent of the population of the United States are either diabetics or potential diabetics. This represents a great increase in the number of diabetics over the past fifteen years. The increase is not distributed uniformly throughout life or in either sex, but has been shown to occur to a greater extent in children and in women between forty and sixty years of age. In both of these age groups, operations are frequently required, not only for conditions commonly associated with diabetes but for lesions entirely foreign to the disease. Some metabolists predict that the stress and strain of the present emergency will further increase the number of diabetics.

If the diabetes is adequately controlled by the metabolist, it adds little or nothing to the operative risk in operations of election. In emergency cases, particularly those complicated by infection, the operative risk is greatly increased. In the treatment of these cases, the closest co-operation between the medical and surgical departments cannot be overemphasized.

Many diabetics are controlled more easily with protamine zinc insulin. Unfortunately, it has proved unsatisfactory to use insulin in this form in the surgical diabetic, as its action may become cumulative at any time, and the insulin requirements of the surgical diabetic may diminish very rapidly. For these reasons, patients so treated often went into severe insulin shock. These shocks occurred most frequently after adequate drainage of an infection or in the preoperative treatment of severe hyperthyroidism associated with diabetes. In the light of this experience, we have discontinued the use of protamine zinc insulin in the surgical diabetic during the immediate preoperative and postoperative periods and, instead, use either regular or crystalline insulin.

The evaluation of abdominal pain in the diabetic may be both interesting and difficult.

We no longer wait until the patient is drowsy or about to go into coma before acidosis is considered. The earlier symptoms and physical findings of acidosis, which may closely simulate those found in acute abdominal conditions, have been clearly demonstrated. Even leucocytosis and fever, so characteristic of the acute abdomen, are associated with acidosis in a high percentage of cases.

When this clinical picture occurs, the surgeon is often called upon to differentiate between acidosis and a surgical abdomen; frequently it is only the urine examination and the subsequent blood sugar and carbon dioxide determination which enables one to arrive at the proper diagnosis. If acidosis is present, it should be treated at once. Under proper treatment the acidosis usually is controlled in four to six hours. Then another abdominal examination should be made to rule out a coexisting abdominal lesion which may require surgical treatment.

In conjunction with Dr. Joseph T. Beardwood, a study was made to evaluate the abdominal pain found in the diabetic and compare it with that which occurred in the nondiabetic. We found that the most severe abdominal pain occurs in diabetic acidosis; in the absence of acidosis, other things being equal, the abdominal pain, due to an underlying pathological process, in the diabetic, is less severe than in the nondiabetic. The last portion of our findings has proved most valuable to us as we had a tendency to underestimate the presence of a surgical lesion in the abdomen of a diabetic, as his symptoms and physical findings did not appear to be severe enough. In our series we now have over fifty diabetics who had lesions in the abdomen associated with pus, and acidosis did not occur in a single case. This is contrary to experience in patients with small collections of pus elsewhere in the body.

Even though acidosis is the most hazardous, infection is the commonest and most serious complication in the surgical diabetic. This is aptly brought to our attention by Dr. E. L. Eliason who pointed out that infection had played a part in 95 per cent of his fatal cases. Since the discovery of the sulfonamides, the various forms of these compounds have been used widely for local applications in infections in the diabetic. Recently the 10 per cent sulfathiazole ointment has been used with excellent results in patients with diabetic gangrene involving only the digits. The number of patients successfully treated by conservative surgery has been increased by the use of this therapeutic agent. This is particularly gratifying when it is considered that these lesions formerly responded very poorly to any form of local therapy. In spite of these favorable reports, experience to date shows that we should not procrastinate in the employment of radical surgery when it is indicated by the local findings and not contraindicated by the patient's general condition. In more extensive processes the local application of sulfanilamide powder, in conjunction with oral administration, has universally proved to be the most effectual. Zinc peroxide was suggested as an antiseptic by Elias in 1903 but it was not until 1937 that F. L. Meleney and A. B. Johnson, after extensive experimental investigations, advocated its use for the local treatment of infections. Their studies showed that the best results were obtained when it was applied closely, as a creamy suspension in sterile distilled water, to every part of the infected surface and evaporation was prevented by sealing the entire dressing with vaseline or ointment. In chronic processes, complicated by sinus formation, daily irrigation with this preparation has proved most efficacious in the diabetic. The profession welcomes both the sulfonamides and zinc per-

oxide as valuable additions to the armamentarium in the treatment of infections in the diabetic.

A study of the various series of diabetic gangrene, as reported from well organized metabolic services, reveals a great deal of variation in the operative mortality. Further analysis shows that the mortality is in direct proportion to the percentage of cases complicated by severe infection. Operative mortality should not be confused with hospital mortality. This also was pointed out by Dr. Eliason in a report of a series of cases of diabetic gangrene; the immediate operative mortality was 3.5 per cent but the hospital mortality rose to 55 per cent in patients who stayed in the hospital for one year.

The highest mortality occurs in the diabetic admitted to the hospital in a very toxic state who has a gangrenous process which will not localize. The investigative work which Dr. F. A. Allen has conducted on refrigeration in surgery may lead to a therapeutic measure which will enable us to treat this group with much greater success. In his early reports he emphasized the fact that metabolic activity is lowered when the temperature of tissue has been reduced and suggested that we lower the temperature of the infected parts in patients having a peripheral vascular lesion from which very toxic substances are absorbed. In the past few months he reported the results which were obtained in forty-five cases of gangrene in which the local application of refrigeration had been used.

Our experience with this form of therapy has been limited to only a few cases but the results have been excellent. In carefully selected cases, particularly the very toxic ones just described, this treatment has merit. These early results warrant the further use and evaluation of refrigeration in surgery.

FREDERICK A. BOTHE.

THE SURGICAL RELIEF OF PAIN

PAIN has lost its useful function when a warning has been given that something is wrong. Treatment of the condition causing pain is the next step. If the lesion is beyond treatment and the pain persists, as in advanced malignant disease, it is equally important that the pain should be relieved.

Pain in cancer is probably not any more severe than pain in many other diseases; yet, there is a widespread popular opinion that cancer is a most painful disease and leads to a painful death. This belief is, no doubt, due to the slow progression and long duration of the terminal painful stage of cancer.

Increased interest in measures for the relief of pain has resulted in the introduction of new procedures and in the extension of the application of others. Some of them are comparatively simple and deserve wider usage. One of the more simple methods is the subarachnoid injection of absolute alcohol introduced by Dogliotti in 1931.

Subarachnoid injection of alcohol for relief of pain is possible, because a small quantity of absolute alcohol can be supernated on the spinal fluid about the pain bearing rootlets, if the patient is properly positioned while the alcohol is slowly injected.

Analysis of the results in 59 patients treated at the University of Minnesota Hospitals by this procedure showed that complete relief was obtained in 61 per cent, partial relief in 27 per cent, and no relief in 12 per cent. Ten patients who were relieved completely were followed 6 months or longer and throughout were free of pain. Possible permanent loss of sphincter control or paralysis of the lower extremities is considered to be a contraindication to the injection of subarachnoid alcohol in nonmalignant disease. Yet, in 81 patients

injected at the University of Minnesota Hospitals, these sequelae have not occurred in the presence of a previously normal spinal cord and cauda equina.

Examination of the spinal cords from 5 individuals, who had been given alcohol injections from 3 to 6 months before death, demonstrated that following unilateral injection, there was unilateral patchy demyelinization of the posterior rootlets and degeneration of the lateral part of the posterior funiculus of the cord at the site of contact with the alcohol. From these findings, it is concluded that relief from pain is due to partial or complete destruction of the small myelinated and unmyelinated fibers present in the posterior rootlets.

Anterolateral cordotomy, or section of the spinothalamic tracts in the upper thoracic segments of the cord, is followed by relief of pain on the contralateral side if the pain is located below the midthoracic region. Rhizotomy of posterior roots can be combined with cordotomy to extend the area of analgesia up to the level of the cordotomy. Anterolateral cordotomy, even when performed on the upper cervical segments for relief of pain in the brachial plexus, does not produce analgesia high enough to be satisfactory. Rhizotomy of the roots of the brachial plexus produces a useless upper extremity anesthetic to all types of sensation. Cordotomy, which leaves intact sensations other than pain and temperature, is ideal for relief of pain in the arm. For this reason operations have recently been devised for section of the spinothalamic tracts in the medulla and even in the midbrain.

Sixteen cordotomies done at the University of Minnesota Hospitals were followed and 13 were found to have been completely relieved of pain. Most of these were for relief of unilateral pain in malignant tumors. Permanent incontinence of urine was not encountered, but to avoid urinary incontinence, which may follow bilateral cordotomy, two patients with bilateral pain were successfully relieved by subarachnoid alcohol injection on one side and cordotomy on the same side for relief of the contralateral pain. This leaves the central and peripheral fibers to the bladder on one side intact, although both central and peripheral fibers on the other side may be injured.

Tractotomy of the spinal tract of the trigeminal nerve in the medulla for relief of pain in the face was introduced by Sjöquist in 1938. Since only pain and temperature sensation is conducted through the spinal tract of the trigeminal nerve, the result is ideal, and this operation would supplant rhizotomy for the relief of trigeminal neuralgia were it not for the fact that all pain fibers are not invariably severed, and sequelae, such as ataxia, inco-ordination, and vertigo may follow the procedure. It is, however, satisfactory for relief of pain of malignant disease, and one can also do a rhizotomy of the glossopharyngeal nerve and upper cervical nerves through the same incision, if the pharynx and cervical region are invaded. WILLIAM T. PEYTON.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE need for a brief, comprehensive exposition of a subject long buried piecemeal in hundreds of papers and texts is amply met by Dr. Noel A. Gillespie's excellent monograph[1]. The author's personal acquaintance with most of the modern exponents of tracheal intubation, his own experience both in England and America, and his knowledge of the history of the subject make him well qualified to write on it.

For the anesthesiologist, it offers the most complete review and discussion of endotracheal methods extant. Every phase of the subject is covered, and profusely illustrated. For the specialist in training, the book should be a valuable source of guidance, bringing into sharp focus the controversial points and offering sound advice on all of them. The repeated cautioning against haste and force in the application of intubation is commendable.

For the surgeon who commands the services of a skilled anesthesiologist, or wishes he could, and particularly for those in the armed forces, this monograph will have the greatest interest and value. The complexity of the anesthesia problem in many operations makes it imperative that the surgeon have access to such a work as this. Just as important as the solution of the mechanical problems of certain procedures by tracheal intubation, is the improvement in working conditions for the surgeon in cranial, spinal, and upper abdominal operations that the near-perfect airway of endotracheal anesthesia provides. Not so widely appreciated is the added factor of safety for the patient when reflex glottic closure, with its attendant asphyxia, is forestalled by intubation.

To paraphrase the foreword of Magill, Waters, and Guedel, "This little book will serve as a guide to improvements in principals and methods which will make endotracheal anesthesia ever more helpful to the surgeon, and a greater protection to his patients."

W. ALLEN CONROY.

IN a well bound nicely printed 500 odd page book the authors of *The Blood Bank and the Technique and Therapeutics of Transfusions*[2] have thoroughly covered the field of blood transfusion. There are 214 illustrations. The bibliographical appendages to each chapter appear to be exhaustive in scope.

The chapters dealing with plasma and serum infusions review this relatively recent development very well. In some other sections of the book a clear distinction between serum and plasma is not made.

Particularly well done is the clear and concise account of recent experimental work in all sections of the book.

The reviewer believes that the authors are mistaken in their contention that fresh citrate transfusions are in any way inferior to those of unmodified blood.

For laboratories, hospitals, or those interested in blood transfusions the book is a necessity.

THOMAS C. DOUGLASS.

THE third revised edition[3] of what the author modestly calls a "hand-book" is prefaced by the statement: "To anyone interested in therapeutics it must seem that the four years since the second edition of this book appeared have been the most exciting within the recollection of most of us." Because this statement is undoubtedly correct, this new edition of a particularly fine book is particularly appropriate at this time.

The book has been completely revised and brought up to date in all respects with special emphasis on the section dealing with drugs and organ extracts used in ophthalmology. This section now contains a brief, readily understandable exposition on the mode of action of the sympathomimetic and parasympathomimetic drugs. Also, and more important, it deals at considerable length with the effect of the sulfonamide derivatives on gonorrheal ophthalmia and trachoma, giving specific dosages and modes of administration. The section on vitamins has been brought up to date by an adequate discussion on therapeutic indications.

It is to be regretted that the author devotes so much space to the treatment by dionin of incipient lens changes, a form of therapy which has long since been discarded by leaders in the field of ophthalmology as being valueless.

The book retains the same format used in previous editions with many of the same illustrations, most of which are excellent. This edition fills a definite need and will be welcomed by ophthalmologists, and it is hoped that the author will continue to offer periodic revisions bringing the material up to date as the occasion offers.

D. SNYDACKER.

[1] ENDOTRACHEAL ANAESTHESIA. By Noel A. Gillespie, D.M., B.Ch., M.A.(Oxon.), D.A.(R.C.S.Eng.). Madison, Wisconsin: University of Wisconsin Press, 1941.

[2] THE BLOOD BANK AND THE TECHNIQUE AND THERAPEUTICS OF TRANSFUSIONS. By Robert A. Kilduffe, A.B., A.M., M.D., F.A.S.C.P., and Michael DeBakey, B.S., M.D., M.S., F.A.C.S. St. Louis, Mo.: The C. V. Mosby Co., 1942.

[3] A HAND-BOOK OF OCULAR THERAPEUTICS. By Sanford R. Gifford, M.A., M.D., F.A.C.S. 3d ed. Philadelphia: Lea & Febiger, 1942.

QUITE frequently medical students, postgraduate students, and practicing physicians whose field does not include neurological surgery desire a comprehensive treatise on the subject. It is possible to compile from the literature a comprehensive survey of neurological surgery but a single volume containing concise, complete discussions on neurological diagnoses, craniocerebral injuries, intracranial tumors, intracranial abscesses, surgical lesions of the cranial nerves, injuries and tumors of the spinal cord, and injuries to the peripheral nerves in conjunction with surgery of the autonomic nervous system, including hypertension, is very difficult to find. In Doctor Davis's monograph,[1] the second edition of which has just been published, one is able to find just such a book and it fulfills a much needed place on the library shelves of many busy physicians who may turn to it in order to keep up with what is being done at the present time for many neurological lesions.

The book is well written and contains excellent photographs, diagrams, and photomicrographs. The size of the volume is convenient and it is attractively bound in buckram.

In the preface the author states definitely that "This book makes no pretense at including an exhaustive treatise upon each subject considered . . . The purpose has been to give to the practitioner of medicine and to the medical student easily assimilable facts which will aid them in getting a more accurate concept of neurological surgery to the end that their patients will receive accurate and sound advice." WINCHELL MCK. CRAIG.

THE reprinting of Dr. Ferguson's excellent book *Roentgen Diagnosis of the Extremities and Spine*[2] has afforded him an opportunity for its enlargement. The additional material includes a new chapter devoted to the lame back. This section approximates the detailed exposition offered in the lame back exhibit at the meetings of the American Medical Association.

The author has drawn liberally from his broad experience in one of the largest orthopedic hospitals. The subject matter is presented in concise and logical manner. The opening chapter on the analysis of roentgenograms must be read carefully if the reader is to understand the definitive roentgenologic nomenclature used by the author. These technical roentgenologic terms appear in bold-faced type throughout the text. Pertinent clinical information is presented at the end of each chapter in short case histories. Frequent references at the foot of each page indicate the illustrations depicting the roentgen feature under discussion. The subject matter is profusely illustrated. The reproductions are in the positive phase rather than in the form of the original negatives.

This book is not the type which can be read lightly. As mentioned previously, a careful perusal of the introduction is necessary if the reader is to take full advantage of the excellent subject matter as presented by the author. The arrangement of the text consists of a tabulation and discussion of roentgen features rather than a discussion of diseases. References for the various diseases, their outstanding features and the definitive technical terms used in description are offered in an extensive but workable index.

The field of roentgenology of the spine and extremities is presented in a concise organized manner. Students and practitioners, particularly roentgenologists and diagnosticians dealing with bones and joints, will find this book to be very useful as a reference work and as a guide in the differential diagnosis of injuries, diseases and deformities of the spine and extremities. EARL E. BARTH.

THE monograph by Dieckmann[3] is the most comprehensive treatise on toxemias of pregnancy that has been published. It is a volume of 500 pages, containing 50 illustrations and 3 colored plates. In the preface Dieckmann states that he had a two-fold objective in the compilation of this work, one to acquaint the obstetrician with some of the recent contributions on physiology pertaining to obstetrics, and the other to acquaint the investigator, untrained in obstetrics, with some of the physiology and pathology of obstetrics.

The book is divided into 6 sections, each of which deals with certain phases of the subject. The first section considers the classification, incidence, and pathology of toxemias. The second section under the heading of normal and abnormal physiology deals with the physicochemical determinations, blood pressure, renal physiology, the liver, the ocular system, the placenta, and the endocrines. Section three deals with the etiology of eclampsia and all factors pertaining to or influencing this condition are discussed. Sections four and five consider the clinical aspects and the treatment of toxemias respectively while the maternal and fetal prognoses are discussed in the last section. Following each chapter, a complete bibliography is found.

The author of this volume has done a tremendous amount of original research in the field of toxemias of pregnancy and is thoroughly familiar with the work of all other investigators in this field. He has presented in this work the results of his own investigations and the conclusions drawn therefrom; the results of other investigators and their conclusions are liberally quoted. Obviously the reader will find himself familiar with much of the material which has been drawn upon in the compilation of this book, for it is in fact a condensed review of all the worth while material produced in recent years on this subject. This volume should be read by everyone interested in the subject of toxemias and retained as a reference thereafter. CHESTER C. DOHERTY

[1] NEUROLOGICAL SURGERY. By Loyal Davis, M.S., M.D., Ph.D., D.Sc. (Hon.). 2d ed. Philadelphia: Lea & Febiger, 1942.

[2] ROENTGEN DIAGNOSIS OF THE EXTREMITIES AND SPINE. By Albert B. Ferguson, M.D. Annals of Roentgenology, Vol. 17. New York: Paul B. Hoeber, Inc., 1941.

[3] THE TOXEMIAS OF PREGNANCY. By William J. Dieckmann, M.D. St. Louis: The C. V. Mosby Co., 1941.

WHEN *Diagnostic Roentgenology* was published 5 years ago the editor and publisher assured the purchaser that additional up-to-date material would be issued at regular intervals. The first renewal service in 1938 consisted of 255 additional text pages and 230 new illustrations. In the second renewal service,[1] the publishers are supplying more than 600 additional pages. The addition of this material as well as a revised and enlarged index, table of contents, and list of contributors has necessitated a second volume, and a new binder (Volume II) is furnished without charge.

The additional material includes five new chapters: "The Roentgen Diagnosis of Fractures and Dislocations," by L. Henry Garland; "Roentgen Diagnosis in Infants and Children," by John Caffey; "Soft-Tissue Roentgenography," by James R. Lingley and William J. Elliott; "Laminagraphy," by Sherwood Moore; "Angiography," by John D. Camp and Edgar V. Allen. An addendum to his chapter on "Radiology of the Chest" has been prepared by Coleman B. Rabin. New material has been added to the chapter on the "Use of the Roentgen-Ray in Obstetrics." The section on "Roentgen-Ray Diagnosis of Diseases of the Skull and Intracranial Contents" has been completely revised by Dr. Cornelius G. Dyke and now comprises 230 pages with 336 illustrations.

The addition of all this new material greatly enhances the value of this already well established contribution. The 1941 two-volume edition of *Diagnostic Roentgenology* represents the most complete and comprehensive presentation of the subject of roentgen diagnosis available in this country. It is recommended not only to the roentgenologist but will be a valuable aid in the diagnostic work of all practitioners. EARL E. BARTH.

THE author of the book, *Clinical Roentgenology of Pregnancy*,[2] intended that it should not only serve to acquaint the reader with the roentgen study of pregnancy but above all enable him to do the work himself. Separate chapters are devoted to a general discussion of the use of x-ray in pregnancy, positioning of the patient, and technique of x-ray exposures, x-ray pelvimetry and cephalometry computations, the pelvic shape and its measurements, the fetus and pelvis, roentgen visualization of the soft tissues in pregnancy, and case reports. The author has drawn liberally from his extensive experience in this field, consequently considerable space is given to a discussion of x-ray visualization of the soft tissues in pregnancy. His own methods of x-ray pelvimetry and cephalometry are described. Distortion of the various pelvic and cephalic diameters as measured on the films are corrected by the use of either a chart which is reproduced in the book or a slide rule devised by the author. Methods other than the author's used for measuring the pelvis and the fetus are discussed briefly in the first chapter. The volume contains 119 illustrations, including reproductions of roentgenograms, line drawings, and photographs of equipment. The illustrations which accompany the case reports are reproduced to scale and are accompanied by the author's measurements and comments, thus providing the reader an opportunity to make his own measurements. Reproductions and line drawings enhance greatly the value of the discussion of the roentgen visualization of the soft tissues in pregnancy.

This volume provides a working manual of pelvimetry for the method described. It can be recommended to the physician who is interested in roentgenography as it pertains to obstetrics.

EARL E. BARTH.

THOUGH rather brief, Padgett's monograph on *Skin Grafting*[3] is devoted to the entire usefulness of skin transplantation. The historical and histological sections and those on preoperative and postoperative treatment are generally inadequate as compared to other recent, more detailed articles on the subject.

The author fails to stress the importance of careful aseptic care of the large open granulating surfaces in either the preoperative or postoperative treatments and this omission might lead to faulty or careless technique by the beginner.

There is nothing in the text to substantiate the statements made on the jacket of the book regarding: "No longer need the physician hesitate as to his dexterity in removing the proper graft. Nor is there further need to fear the failure of a 'take'."

The book contains no new principle but is devoted to explaining a new mechanical device for the removal of skin for grafting. HARVEY ALLEN.

THE book, *Roentgen Treatment of Infections*,[4] is primarily a presentation, in book form, of the authors' cases of gas gangrene, peritonitis, and pneumonia treated with x-rays. A few additional paragraphs are included to mention the value of x-ray therapy in erysipelas, boils, Ludwig's angina, nail puncture, impetigo, acne, plantar warts, sinusitis, meningitis, and other conditions. The discussion and literature citations on the latter group are very incomplete and misleading.

The term "gas gangrene" is very hazily defined but the definition serves adequately for subsequent exhorbitant claims concerning the value of x-ray therapy. Reference is repeatedly made to the "antitoxic" value of x-rays which has no factual basis. The authors likewise emphasize "symbiosis" in the etiology of gas gangrene which also is without experimental proof.

[1] DIAGNOSTIC ROENTGENOLOGY. Edited by Ross Golden, M.D. 1941 Renewal Pages, Volumes I and II. New York: Thomas Nelson & Sons, 1941.

[2] CLINICAL ROENTGENOLOGY OF PREGNANCY. By William Snow, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1942.

[3] SKIN GRAFTING; FROM A PERSONAL AND EXPERIMENTAL VIEWPOINT. By Earl Calvin Padgett, M.D., F.A.C.S. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1942.

[4] ROENTGEN TREATMENT OF INFECTIONS. By James F. Kelly, M.D., F.A.C.R., and D. Arnold Dowell, M.D. Chicago, Ill.: The Year Book Publishers, Inc., 1942.

The work is well outlined and convenient data are available to enable the inexperienced to treat infections by the method. A very short section is devoted to the basic principles of the x-ray machine. There is still a great need for a complete literature review to evaluate in unbiased fashion the clinical and experimental value of x-rays in treatment of various inflammatory processes. LYLE A. WEED.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

DISEASES AND INJURIES OF THE LARYNX; A TEXTBOOK FOR STUDENTS AND PRACTITIONERS. By Chevalier Jackson, M.D., Sc. D., LL.D., F.A.C.S., and Chevalier L. Jackson, A.B., M.D., M.Sc. (Med.), F.A.C.S. New York: The Macmillan Co., 1942.

THE NATIONAL FORMULARY—SEVENTH EDITION; NATIONAL FORMULARY VII, N.F. VII. Prepared by the Committee on National Formulary by authority of the American Pharmaceutical Association. Official from November 1, 1942. Washington, D. C.: American Pharmaceutical Association, 1942.

NUTRITION AND CHEMICAL GROWTH IN CHILDHOOD. Volume 1—EVALUATION. By Icie G. Macy, Ph.D., with a foreword by Hugo A. Freund, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1942.

OCCUPATIONAL TUMORS AND ALLIED DISEASES. By W. C. Hueper, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1942.

INTESTINAL OBSTRUCTIONS; A PHYSIOLOGICAL AND CLINICAL CONSIDERATION WITH EMPHASIS ON THERAPY INCLUDING DESCRIPTION OF OPERATION PROCEDURES. By Owen H. Wangensteen, B.A., M.D., Ph.D. 2d ed. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1942.

DIAGNÓSTICO DE LOS TUMORES ABDOMINALES; ONCOQUILIAGNOSIS. By Pablo L. Mirizzi. Vols. 1 and 2. Buenos Aires: El Ateneo, 1941 and 1942.

ANGIOGRAFÍA CONTRASTADA. By Eduardo C. Palma. Foreword by Prof. A. Ceballos. Montevideo, Uruguay: A. Monteverde and Co., 1942.

PRINCIPLES OF EXTRAPERITONEAL CAESAREAN SECTION. By James V. Ricci, A.B., M.D., and James Pratt Marr, M.D., F.A.C.S. Philadelphia: The Blakiston Co., 1942.

THE RECEPTION OF WILLIAM BEAUMONT'S DISCOVERY IN EUROPE. By Dr. George Rosen. With a foreword by Dr. John F. Fulton. New York: Schuman's, 1942.

THE SURGERY OF PANCREATIC TUMORS. By Alexander Brunschwig, M.S., M.D., F.A.C.S. St. Louis: The C. V. Mosby Co., 1942.

THE CARE OF THE AGED (GERIATRICS). By Malford W. Thewlis, M.D. 4th ed. St. Louis: The C. V. Mosby, Co., 1942.

STANDARD NOMENCLATURE OF DISEASE AND STANDARD NOMENCLATURE OF OPERATIONS. Edited by Edwin P. Jordan, M.D. Chicago: American Medical Ass., 1942.

PHYSICAL DIAGNOSIS. By Cabot and Adams. 13th ed. by F. Dennette Adams, M.D. Baltimore: The Williams & Wilkins Co., 1942.

STEDMAN'S PRACTICAL MEDICAL DICTIONARY. 15th rev. ed. By Stanley Thomas Garber, B.S., M.D. Baltimore: The Williams & Wilkins Co., 1942.

PSYCHOTHERAPY IN MEDICAL PRACTICE. By Maurice Levine, M.D. New York: The Macmillan Co., 1942.

CHINA'S HEALTH PROBLEMS. By Szeming Sze, M.A., M.B., B.Ch. (Cantab). New York: China Institute in America, Inc., 1942.

WAR MEDICINE; A SYMPOSIUM. Edited by Winfield Scott Pugh, M.D., Commander, (M.C.) U.S.N. Retired, Edward Podolsky, M.D., and Dagobert D. Runes, Ph.D. New York: Philosophical Library, 1942.

LA BIOPSIA POR ASPIRACION EN EL DIAGNOSTICO DE LAS LESIONES OSEAS. By Dr. Jose Valls, Dr. Carlos E. Ottolenghi, and Dr. Fritz Schajowicz. Buenos Aires: El Ateneo, 1942.

DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY. By Hamilton Bailey, F.R.C.S. (Eng.). 8th ed., revised. Baltimore: The Williams & Wilkins Co., 1942.

A TEXTBOOK OF GYNECOLOGY. By Arthur Hale Curtis, M.D. 4th ed. Philadelphia and London: W.B. Saunders Co., 1942.

THE HAND; ITS DISABILITIES AND DISEASES. By Condict W. Cutler, Jr., M.D., F.A.C.S. Philadelphia and London: W.B. Saunders Co., 1942.

SYNOPSIS OF PATHOLOGY. By W. A. D. Anderson, M.A., M.D. St. Louis: The C. V. Mosby Co., 1942.

THE PROSPECTIVE MOTHER; A HANDBOOK FOR WOMEN DURING PREGNANCY. By J. Morris Slemons, M.D., with a chapter by Phillip E. Rothman, M.D. 4th ed. New York and London: D. Appleton-Century Co., 1942.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

W. EDWARD GALLIE, Toronto, *President*
IRVIN ABELL, Louisville, *President-Elect*

Committee on Arrangements

THOMAS E. JONES, *Chairman;* JOHN W. HOLLOWAY, *Secretary*

1942 CLINICAL CONGRESS IN CLEVELAND—A WAR SESSION

UNDER the direction of the Board of Regents, a four-day program is being developed for the thirty-second annual Clinical Congress, to be held in Cleveland, November 17 to 20, with headquarters at the Cleveland Public Auditorium. This fine, large building, with its Arena, Music Hall, Little Theater, Ballroom, and other large halls, provides exceptional facilities, so that all activities of the Congress, excepting the clinical program, will be housed in that building. The program of the Congress in general will be based upon the many medical and surgical problems arising out of the prosecution of an all-out effort to win the war, emphasizing the needs of the rapidly expanding medical services of the Army and Navy, with consideration of the special problems related to the increasing activities for civilian defense.

CLINICAL PROGRAM

The surgeons of Cleveland have organized, with Dr. Thomas E. Jones as chairman, and Dr. John W. Holloway as secretary of the Committee on Arrangements. In the following pages there is presented a preliminary clinical program as prepared by the committee, consisting of operative clinics and demonstrations that will provide a comprehensive showing of their clinical activities in all departments of surgery at Western Reserve University School of Medicine and the approved hospitals of Cleveland. Under the leadership of this committee, representative of the interests of all surgical specialties, a complete and varied program is assured for the 1942 Congress. It will be noted that the program includes the presentation of the latest advances in diagnostic methods, operative procedures, pre- and postoperative care of the surgical patient. Clinics and demonstrations will be held in the hospitals on the afternoon of Tuesday, November 17, and the mornings and afternoons of the succeeding days.

The final clinical program to be presented at the Cleveland hospitals will be arranged to include a wide variety of subjects in general surgery, obstetrics and gynecology, fractures and other traumas, orthopedic surgery, urological surgery, neurosurgery, thoracic surgery, ophthalmology and otolaryngology. The presentations at the hospitals under these classifications will be so correlated that the visiting surgeon may devote his time to those clinics dealing with the special subjects in which he is most interested. A complete detailed clinical program for each day will be posted in the form of bulletins at headquarters during the afternoon of the preceding day and distributed in printed form each morning

GENERAL ASSEMBLY

The Clinical Congress will open with a general assembly at headquarters at 9:30 on Tuesday morning. From the program, which appears on another page, it will be noted that the speakers at this assembly are leading figures in the wartime medical activities. The Surgeons General of the Army, Navy and Public Health Service, the chief of the medical division of the Office of Civilian Defense, and the chairman of the Directing Board of the Procurement and Assignment Service will be present to discuss the activities of their respective branches of service. The president of the American College of Surgeons, Dr. W. Edward Gallie, of Toronto, will speak on "Medical and Hospital Service in the War" and will preside at this assembly. The chairman of the Board of Regents, Dr. Irvin Abell, of Louisville, will review what has been accomplished by the College in the field of hospital standardization during 25 years, and will report upon the field

activities of the College and officially announce the approved lists of hospitals, cancer clinics, hospitals approved for graduate training in surgery and the surgical specialties, medical services in industry, and medical motion pictures.

PRESIDENTIAL MEETING AND CONVOCATION

The impressive and colorful ceremony surrounding the reception into fellowship of the 1942 class of initiates, the conferring of honorary fellowships upon distinguished surgeons, and the inauguration of officers of the College for the 1942–1943 term will take place on Tuesday evening in the Music Hall of the Public Auditorium. Distinguished surgeons from foreign countries attending the Congress will be introduced, and the presidential address by the retiring president, Dr. W. Edward Gallie, of Toronto, will follow.

Appearing on the program will be the Surgeons General of the Army, Navy, and Public Health Service, and the Chief Medical Officer of the Office of Civilian Defense. The final feature of the evening's program will be the presentation of the 1942 medical records prize award to that candidate for fellowship who has, in the opinion of the judges, presented the most acceptable set of case records and the honor list of candidates who were awarded honorable mention for their case records. The prize award of $500 is made by SURGERY, GYNECOLOGY AND OBSTETRICS, to be invested in the name of the successful candidate for a life membership in the College.

PANEL DISCUSSIONS ON WAR SURGERY

Concentration of interest on various phases of surgery as related to the war effort impelled the Board of Regents to change from the usual plan of holding several panel discussions simultaneously on various specialized subjects to a program of master panels that deal with the important phases of war surgery, to be held consecutively. Similar panels proved to be most interesting and beneficial during the "War Sessions" held by the College in several large cities during the early part of the year.

This plan makes it possible for surgeons to attend all the panels. Ample accommodations are afforded in the Music Hall of the Public Auditorium for the large audiences which will be attracted by these master panel discussions, scheduled to be held each afternoon, Tuesday through Friday, and on Wednesday, Thursday and Friday evenings. The leaders and collaborators in the panel discussions will include surgeons in active military service and eminent surgeons from civilian ranks. In the following pages there appears a detailed program for these master panel discussions, indicating the subjects to be presented and the leading participants therein.

In addition to the panel discussions on Wednesday evening, Captain Frederick R. Hook, M.C., U.S.N., will deliver the annual oration on surgery —"Wounds in Combat."

EXECUTIVE COMMITTEE

Thomas E. Jones, Chairman	C. Lee Graber
John W. Holloway, Secretary	John E. Hannibal
Arthur H. Bill	Carl H. Lenhart
Abram B. Bruner	Thomas P. Shupe
John F. Corrigan	Abraham Strauss
Clarence W. Engler	Oliver A. Weber
Samuel O. Freedlander	Theodore A. Willis

HOSPITALS AND REPRESENTATIVES

City Hospital—Samuel O. Freedlander.
Cleveland Clinic Hospital—Robert S. Dinsmore.
Evangelical Deaconess Hospital—Oliver A. Weber.
Fairview Park Hospital—F. H. J. Heyse.
Glenville Hospital—Jacob E. Tuckerman.
Grace Hospital—A. E. Biddinger.
Huron Road Hospital—Benjamin B. Kimmel.
Lakeside Hospital—Frederick R. Mautz.
Lakewood Hospital—C. Lee Graber.
Lutheran Hospital—Frank S. Gibson.
Maternity Hospital—W. R. Barney.
Mount Sinai Hospital—Abraham Strauss.
Polyclinic Hospital—A. F. Spurney.
St. Alexis Hospital—John F. Corrigan.
St. Ann's Maternity Hospital—E. P. Monaghan.
St. John's Hospital—Farrell T. Gallagher.
St. Luke's Hospital—Russell S. McGinnis.
St. Vincent's Charity Hospital—Oliver A. Weber.
United States Marine Hospital—S. A. DeMartini.
Woman's Hospital—B. B. Colvin.

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

At the 1941 Clinical Congress in Boston, the "Forum on Fundamental Surgical Problems" achieved a great success, and will again have an important place on the program for the Cleveland session. Under the chairmanship of Dr. Owen H. Wangensteen, of the University of Minnesota, a committee is preparing the program to be presented on Wednesday, Thursday, and Friday mornings, providing an opportunity for the younger men, representing various university departments of surgery, clinics, and hospitals, to present before a large surgical meeting the important results of their clinical and experimental research work.

Dr. Wagensteen comments as follows on the purpose of the program for the forum:

> This portion of the program, instituted by the Board of Regents to provide an opportunity for the presentation of the results of original clinical and experimental research, established itself in its first session a year ago and appears to have satisfied a long-felt need. It afforded a large surgical audience

the opportunity to become acquainted with the work of many productive clinical and experimental investigators through the medium of the concise presentation; at the same time, it accorded a number of young, well-trained surgeons their first opportunity of a hearing before a national surgical organization. In the past, not infrequently, young surgeons have found it necessary to have their work receive recognition before another audience before surgeons would deign to hear them. The late William J. Mayo felt keenly that the wisdom of age and experience should be exchanged freely with the enthusiasm of youth, and that both old and young would benefit by the barter. In the main, the most original contributions to surgery are made by young men. For the improvement of surgery, as well as the enlightenment of surgeons with greying hair and other eloquent marks of advancing years, it is important that young, productive workers in surgery be provided an opportunity early in their careers for active participation in surgical gatherings—before the ravages of time dampen their enthusiasm.

Furthermore, surgeons are not long the best company for one another. Surgeons need the vitalizing influence which comes from association with workers in other fields of medicine. Hence, programs constituted year after year only from the membership of a like-minded group of men, such as surgeons, are likely to reveal traces of nutritive deficiencies. No group of medical men can suffer isolation long without exhibiting unmistakable evidences of want. Recognizing the great importance to surgeons of the life-giving spirit and vital sustenance to be gained through association with fellow workers in the broad domain of medicine, the Board of Regents of the American College of Surgeons has authorized inclusion of papers of general interest to surgeons, emanating from the pens of investigators in other provinces of medicine. The interests of the membership of a large organization are served best by provision for the most original and stimulating papers that come within the scope of concern of its auditors, and that are pertinent to the occasion. It is unimportant whether the papers come from within the membership or by invitation to non-members.

It is the professed purpose of the surgical forum to attempt to bring before its assembly each year the best that is new in surgery. This venture has had the hearty support of the professors of surgery in the medical schools of the American universities. The interest manifested in the first program presented at last year's meeting suggests that the surgical forum will come to be an integral part of the Clinical Congress of the American College of Surgeons. If there can be realized the endeavor to bring annually to the Clinical Congress the best creative thought and original achievement in American surgery, the surgical forum will continue to perform a useful function. The surgical forum might well become the federated surgical society of America embracing, as does its preclinical prototype, a number of related specialties. There is a great need for more intimate co-ordination between the scientific programs of the various surgical specialties such as anesthesia, neurosurgery, orthopedics, plastic surgery, thoracic surgery, urologic surgery, and their parent mother, general surgery. The surgical forum is serving to focus important notice upon a rather large group of young men in universities who are making worth-while contributions to the progress of surgery. The sponsors of the forum nourish the hope that this new venture will afford productive men, both young and old, through the whole range of surgery, a useful outlet for the announcement of the results of their investigations. An annual program, embracing new accomplishments in the several provinces of surgery and the most original thought, will be attractive and reciprocally advantageous to participant and auditor alike. Such a program has in it the cement substance to unify by a common bond the progressive spirit of the best in American surgery and its specialties. Realization of such an objective would infuse into our handicraft more of the scientific outlook and leave an indelible impress upon American surgery for the better.

This year our country is at war. The staffs of our surgical clinics have been depleted and everyone's chief concern is focused on the war and its successful prosecution. Yet it is important that scientific meetings continue for the purpose of instruction and for the announcement of newfound knowledge.

In the selection of presentations at the surgical forum the committee is guided by originality of thought and interest suggested in the abstracts submitted by the authors. Each speaker will be allowed ten minutes for his presentation. Anyone interested in participating in the program is invited to send at once the title of his presentation, accompanied by an abstract of not more than 200 words, to the Surgical Forum, American College of Surgeons, 40 East Erie Street, Chicago.

SURGERY OF THE EYE, EAR, NOSE AND THROAT

The general program of the Congress includes many features of special interest to those surgeons whose practice is limited to ophthalmology and otorhinolaryngology. Operative clinics and demonstrations will be given daily at the hospitals. Programs for a series of clinical conferences on Wednesday, Thursday and Friday mornings and panel discussions on Wednesday, Thursday and Friday evenings at headquarters will be found in the following pages. At the morning conferences subjects of timely interest to specialists in these fields will be discussed in small groups. Outstanding specialists will lead the discussions and opportunity will be provided for questions and participation. Preceding each morning and evening session selected motion picture films related to special subjects in these fields will be exhibited.

CANCER CONFERENCE

A cancer conference, sponsored by the Cancer Committee of the College, will be held on Thursday morning. A report on an experiment to control cancer of the uterus will be made. Some of the surgical problems connected with pulmonary, abdominal, and rectal carcinoma will be presented by pioneers in this work. Lessons learned from the experiences with cancer clinics by the College will be presented, as well as a report on further 5-year cures of cancer. This cancer symposium will be of interest not only to those who are interested in organization for cancer control, but also to surgeons under whose immediate care cancer cases susceptible of surgical treatment may come.

HOSPITAL STANDARDIZATION CONFERENCE

Major emphasis in the program for the twenty-fifth annual Hospital Standardization Conference will be upon wartime and postwar problems. Those in attendance will participate in the opening session of the Clinical Congress at 9:30 Tuesday morning in the Cleveland Public Auditorium, which has been mentioned previously under the heading of "General Assembly," and which will be addressed by the Surgeons General of the Army, Navy, and Public Health Service, and other well-known leaders in wartime medical activities. The 1942 list of approved hospitals, hospitals approved for graduate training in surgery, and approved cancer clinics, will be announced at this session by the Chairman of the Board of Regents of the College, Dr. Irvin Abell, who will also review the record of accomplishments of the College in the hospital field during twenty-five years.

Emphasis will be placed in the hospital conference on the more scientific and technical phases of hospital care. In order to cope with the problems created by wartime shortages, the present day administrator must have knowledge of the newer ideas and procedures that are being developed in war medicine and surgery. Surgeons, surgical specialists, pathologists, and anesthetists will, in a series of panel discussions, present discussions of the newer therapies in civilian and military practice, stressing the administrative or service significance. The obvious desirability of complete co-operation by the administrative staff with the medical staff in the emergencies which may be expected in a war period makes this part of the program of outstanding interest to both medical and administrative personnel. Reference is made for details to the hospital program appearing on another page.

Special attention is called to the Wednesday evening conference on "Civilian Defense As Related To Hospitals," which will be conducted by Dr. George Baehr. This will be followed by a round table discussion in which opportunity will be provided for obtaining authoritative answers to questions that have arisen in connection with the part of the hospital in civilian defense.

The breakfast conference on "Inter-American Hospital Relations" on Wednesday morning should attract a large attendance in view of the paramount importance of cementing medical and hospital ties between the Americas as a vital part of the "Good Neighbor" policy. A breakfast conference is also planned, it will be noted, for Thursday morning, on "Hospital Public Relations," in which three of the speakers will be representatives of newspapers, with a fourth presenting the hospital point of view.

The program for the final day, Friday, opens with a large general panel round table conference on "War and Postwar Problems of Hospitals." The war has brought many new problems to confront our hospitals in rendering service to the patient. These problems are in the main most difficult to solve and in fact some of them appear insurmountable. The only way in which they can be approached with hope of a solution is to regard each one as a challenge to supreme effort in the all-out program to win the war. The hospital is contributing personnel to the military services, but it must not let these losses weaken the health defense of its community. In this conference ways and means of overcoming the difficulties of maintaining adequate service in all departments of the hospital which contribute to the care of the patient will be considered.

In the afternoon of the final day there will be opportunity for choice between attending the panel discussion on "Evacuation and Hospitalization of Wounded in Theaters of Operation," the conference on "Making and Evaluating Medical Motion Pictures;" or participating in the study tour of local hospitals.

The program throughout has been planned to interest all types of hospital personnel who are concerned with directing the course of hospitals through the critical war period, and of course this includes the important group that serve as members of governing boards.

SCIENTIFIC EXHIBITS

Exhibits portraying the activities of the American College of Surgeons will be on display, and other national organizations have been offered an opportunity to present exhibits showing

phases of their work. Also there will be individual exhibits demonstrating some phases of fracture work, bone sarcoma, and refrigeration anesthesia. The Office of Civilian Defense will have an exhibit portraying the operations of an emergency medical service, particularly the treatment of burns, and work in connection with blood plasma banks.

RAILROAD TRANSPORTATION

While no special rates have been authorized for the 1942 Clinical Congress in Cleveland by the railroads of the United States and Canada, round-trip tickets to Cleveland, sold at less than double the regular one-way fare, will be available from all points in the United States and Canada. No certificates are required. Return limit and stopover privileges on such round-trip tickets are liberal but are not uniform in all sections of the country. Surgeons planning to attend the Congress should consult local ticket agents in advance of the meeting for complete information as to fares, routes, stopover privileges, etc. It is important that pullman reservations be made at the earliest possible date as the railroads are handling a large amount of passenger traffic. The suggestion is made that travellers will find daytime trains within an area of 400 to 500 miles from Cleveland are less crowded than night trains.

SURGICAL MOTION PICTURES

Daily presentation at headquarters of a large and varied program of surgical motion pictures is planned. The latest available films, on a wide variety of subjects of interest to the surgeon, will be included. Both sound and silent, standard and color films that have been approved by the Committee on Medical Motion Pictures will be shown.

ADVANCE REGISTRATION AND REGISTRATION FEES

The hospitals and medical school of Cleveland afford accommodations for a large number of visiting surgeons, but attendance must be limited at the clinics to the number that can be comfortably accommodated. It is expected, therefore, that surgeons who wish to attend the Congress will register in advance. As in previous years, admission to clinics and demonstrations in the hospitals and to certain of the scientific meetings at headquarters will be controlled by means of tickets issued to the visiting surgeons on application at the registration desk. This plan provides for the distribution of visitors and helps to insure against overcrowding. Surgeons are urged to cooperate in making the clinic ticket plan a success.

In accordance with a resolution adopted by the Board of Regents, fellows of the College whose dues are paid to December 31, 1941, initiates of the class of 1942, and fellows in military service will not be required to pay a registration fee for the 1942 Clinical Congress. For endorsed junior candidates the fee is $5.00. Surgeons, not fellows, who attend as invited guests of the College, will pay a registration fee of $10.00.

For purposes of identification at the registration desk, fellows should present their fellowship cards. Those surgeons who pay the registration fee in advance will receive a formal receipt which they will exchange for a general admission card upon presentation at the registration desk in the Cleveland Public Auditorium.

HEADQUARTERS—TECHNICAL EXHIBITION

Headquarters for the Congress will be established at the Public Auditorium, which affords unusual facilities for accommodating the Congress. All activities except the clinics at the hospitals will be held in this building.

The Technical Exhibition, together with the registration and clinic ticket desk, will be located in the arena on the main floor of the Auditorium. The daily clinical program will be posted there, in the form of bulletins. Leading manufacturers of surgical instruments and supplies, sutures, dressings, pharmaceuticals, operating room equipment, x-ray apparatus and hospital equipment of all kinds, as well as publishers of medical books will be represented in the exhibition. An opportunity for careful inspection of the latest products of all those industries which are aiding the work of the surgeon and the hospital, will be provided for the visiting surgeons and hospital personnel.

CLEVELAND HOTELS AND THEIR RATES

Cleveland has many first-class hotels, several within walking distance of the Public Auditorium, providing ample hotel facilities at reasonable rates. It is suggested that reservation of hotel accommodations be made at an early date.

	Minimum rate with bath	
	Single	Double
Allerton, Chester at East 13th St.	$2.50	$4.00
Auditorium, St. Clair at East 6th St.	2.00	4.00
Carter, Prospect at East 9th St.	3.00	4.50
Cleveland, Public Square	3.00	4.50
Hollenden, 610 Superior Ave , N.E.	3.00	4.50
Lake Shore, 12506 Edgewater Ave.	3.50	6.00
New Amsterdam, Euclid at East 22nd St.	2.00	3.00
Olmsted, Superior at East 9th St.	2.50	4.00
Sovereign, East Blvd. and East 105th St.	3.00	4.00
Statler, Euclid at East 12th St.	3.00	4.50
Tudor Arms 10660 Carnegie Ave.	3.30	5.00
Wade Park Manor Park Lane at East 107th St.	3.50	5.00

ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

Tuesday, 9:30 a.m.—Music Hall, Public Auditorium

Opening Session of War Congress—General Assembly. W. EDWARD GALLIE, M.D., Toronto; President, American College of Surgeons, presiding.

Presentation of Report of Field Activities of the American College of Surgeons for 1942, and Summarization of a Quarter Century of Hospital Standardization. IRVIN ABELL, M.D., Louisville; Chairman, Board of Regents, American College of Surgeons.

Medical and Hospital Service in Canada During the War. W. EDWARD GALLIE, M.D., Toronto.

United States Army Medical Service in the War. Major General JAMES C. MAGEE, Washington; Surgeon General, United States Army.

United States Naval Medical Service in the War. Rear Admiral ROSS T. MCINTIRE, Washington; Surgeon General, United States Navy.

The Health of the Nation in Wartime. THOMAS PARRAN, M.D., Washington; Surgeon General, United States Public Health Service.

Civilian Defense in Its Relation to Medical and Hospital Service. GEORGE BAEHR, M.D., Washington; Chief Medical Officer, United States Office of Civilian Defense.

The Procurement and Assignment Service. FRANK H. LAHEY, M.D., Boston; Chairman, Directing Board, Procurement and Assignment Service.

Tuesday, 2:00 p.m.—Little Theater, Public Auditorium

Rev. Monsignor MAURICE F. GRIFFIN, Cleveland, presiding.

Maintaining Our Voluntary Hospital System During and After the War. Rev. Monsignor MAURICE F. GRIFFIN, Cleveland.

Adjusting Hospital Administration and Services to War and Postwar Conditions. JAMES A. HAMILTON, New Haven, Conn.

Meeting the Medical Personnel Needs of the Armed Forces and Maintaining Adequate Medical Services in Civilian Hospitals. FRANK H. LAHEY, M.D., Boston.

Meeting the Nursing Needs of the Armed Forces and Maintaining Adequate Nursing Services in Civilian Hospitals. JULIA C. STIMSON, R.N., New York.

Maintaining Medical and Nursing Services in Canadian Hospitals During the War. G. HARVEY AGNEW, M.D., Toronto.

Wednesday, 7:45 a.m.—Statler Hotel

Breakfast Conference on Inter-American Hospital Relations. W. FRANKLIN WOOD, M.D., Waverley, Mass., presiding.

Plans for the Promotion of Inter-American Relations. FELIX LAMELA, San Juan, Puerto Rico.

General Discussion. Opened by DONALD C. SMELZER, M.D., Philadelphia.

Wednesday, 9:30 a.m.—Little Theater, Public Auditorium

LEE S. LANPHER, Cleveland, presiding.

Panel Discussions:

The Requirements, Organization, and Operation of Blood and Plasma Banks. SIDNEY O. LEVINSON, M.D., Chicago.

Managing the Intern Problem Under the Accelerated Medical Education Program. C. D. CREEVY, M.D., Minneapolis.

The Problem of Maintaining Adequate Supplies and Equipment for Civilian Hospitals During the War. EVERETT W. JONES, Washington.

The Problem of Maintaining Adequate Medical Records in Civilian Hospitals During the War, and Its Solution. CHRISTOPHER G. PARNALL, M.D., Rochester, N.Y.

Wednesday, 2:00 p.m.—Little Theater, Public Auditorium

Panel Discussions:

The Responsibility of the Administrative Staff of the Hospital in Dealing with Common Emergency Procedures. Conducted by FRED G. CARTER, M.D., Cleveland.

Posttonsillectomy Hemorrhage. CARL H. MCCASKEY, M.D., Indianapolis.

Respiratory Obstruction Requiring Intubation or Emergency Tracheotomy. HORACE E. MITCHELL, M.D., Cleveland.

Sudden Collapse of Postoperative Patient Due to Pulmonary Embolus. MARSHALL DAVISON, M.D., Chicago.

Emergencies Arising During the Administration of Anesthesia. RALPH T. KNIGHT, M.D., Minneapolis.

Acute Cardiac Attack, Coronary Thrombosis. ROY W. SCOTT, M.D., Cleveland.

Sudden Collapse on Operating Table. GILSON C. ENGEL, M.D., Philadelphia.

Hemorrhage—Acute and Postpartum. RALPH E. CAMPBELL, M.D., Madison, Wis.

Acute Poisoning. CHARLES W. MYERS, M.D., Indianapolis.

Wednesday, 8:00 p.m.—Little Theater, Public Auditorium

Special Conference on Civilian Defense as Related to Hospitals. Conducted by GEORGE BAEHR, M.D., Washington.

General Statement from the Office of Civilian Defense. GEORGE BAEHR, M.D., Washington.

Relation of the Medical Officer, Civilian Defense Region, to the Hospital. JOHN S. COULTER, M.D., Chicago.

Arrangements of the United States Public Health Service and the Office of Civilian Defense for Providing and Financing Medical Care for Civilian Casualties. DEAN A. CLARK, M.D., Washington.

The Establishment of Emergency Base Hospitals. HENRY N. HOOPER, Washington.

Round Table Discussion. Conducted by ROBIN C. BUERKI, M.D., Philadelphia.

Motion Pictures: Emergency Medical Service and Medical Aspects of Chemical Warfare.

Thursday, 7:45 a.m.—Statler Hotel

Breakfast Conference on Public Relations in Wartime. MALCOLM T. MACEACHERN, M.D., Chicago, presiding.

Hospitals in the News. DAVID DIETZ, Cleveland; JOSEPHINE ROBERTSON, Cleveland; HOWARD W. BLAKESLEE, New York; THADDEUS ALLEN, Chicago.

Thursday, 9:30 a.m.—Little Theater, Public Auditorium

Panel Discussions:

What the Hospital Administrator Should Know About the Newer Procedures and Therapies Developing During the War in Order to Provide Adequate Services for War and Civilian Injuries. Conducted by EVERETT I. EVANS, M.D., Richmond, Va.

Head Injuries. MAX M. PEET, M.D., Ann Arbor, Mich.
Shock. ALTON W. OCHSNER, M.D., New Orleans.
Flesh Wounds. Captain FREDERICK R. HOOK, M.C., U.S.N., Oakland, Cal.
Burns. VINTON E. SILER, M.D., Cincinnati.
Fractures. Major R. ARNOLD GRISWOLD, M.C., U.S.A., Atlanta, Ga.
Chest Injuries. CAMERON HAIGHT, M.D., Ann Arbor.

Thursday, 2:00 p.m.—Little Theater, Public Auditorium

Panel Discussions:
Maintaining Standards of Service in Hospitals During the Present War. Conducted by EDGAR BLAKE, Chicago.
Importance of Maintaining Peacetime Standards of Hospital Services Not Directly Related to the War. ROBERT JOLLY, Houston, Texas.
Maintaining the Quality of Medical Staff Conferences and Pathological Conferences for the Thorough Review and Analysis of the Clinical Work. VERNE C. HUNT, M.D., Los Angeles.
Maintaining Standards of Pathological Service in Civilian Hospitals in View of the Need of the Armed Forces for Pathologists and Technicians. FRANK W. HARTMAN, M.D., Detroit.
Maintaining Standards of X-ray Services in Civilian Hospitals in View of the Need of Radiologists and Technicians for the Armed Forces. B. R. KIRKLIN, M.D., Rochester, Minn.

Thursday, 7:30 p.m.—Little Theater, Public Auditorium

Motion Pictures—a program of interesting motion pictures for hospital personnel.

Friday, 9:30 a.m.—Little Theater, Public Auditorium

Panel Round Table Conference:
Problems Affecting Hospitals During Wartime and Postwar Adjustments. ROBIN C. BUERKI, M.D., Philadelphia; ROBERT JOLLY, Houston, Texas; MALCOLM T. MACEACHERN, M.D., Chicago.
The war has brought many new problems to confront our hospitals in rendering service to the patient. These problems are in the main most difficult to solve and some of them appear insurmountable. The only way in which they can be approached with hope of a solution is to regard each one as a challenge to supreme effort in the all-out program to win the war. The hospital must support the military services to the fullest extent and at the same time it must not weaken the health defense of the community. In this conference we shall consider ways and means of overcoming the difficulties of maintaining adequate service in all departments of the hospital which contribute to the care of the patient.

Friday, 1:00 p.m.—Music Hall, Public Auditorium

Panel Discussion:
Evacuation and Hospitalization of Wounded in Theaters of Operation. Leaders: Captain JOHN P. OWEN, M.C., U.S.N., Quantico, Va.; Lieutenant Colonel A. L. GORBY, M.C., U.S.A., Washington,

Friday, 2:00 p.m.—Little Theater, Public Auditorium

Conference on Medical Motion Pictures—Making and evaluating medical motion pictures.

Friday, 2:00 p.m.

Study tour of local hospitals.

GENERAL ASSEMBLY—WAR SESSION

Tuesday, 9:30 a.m.—Music Hall, Public Auditorium

W. EDWARD GALLIE, M.D., Toronto; President, American College of Surgeons, Presiding.

Presentation of the Report of Field Activities of the American College of Surgeons for 1942, and Summarization of a Quarter Century of Hospital Standardization. IRVIN ABELL, M.D., Louisville; Chairman, Board of Regents, American College of Surgeons.

Medical and Hospital Service in Canada During the War. W. EDWARD GALLIE, M.D., Toronto.

United States Army Medical Service in the War. Major General JAMES C. MAGEE, Surgeon General, United States Army, Washington.

United States Naval Medical Service in the War. Rear Admiral Ross T. MCINTIRE, Surgeon General, United States Navy, Washington.

The Health of the Nation in Wartime, Surgeon General THOMAS PARRAN, M.D., United States Public Health Service, Washington.

Civilian Defense in Its Relation to Medical and Hospital Service. GEORGE BAEHR, M.D., Medical Director (R.), U.S.P.H.S., Chief Medical Officer, United States Office of Civilian Defense, Washington.

The Procurement and Assignment Service. FRANK H. LAHEY, M.D., Boston; Chairman, Directing Board, Procurement and Assignment Service.

PRESIDENTIAL MEETING AND CONVOCATION

Tuesday, 8:15 p.m.—Music Hall, Public Auditorium

W. EDWARD GALLIE, M.D., Toronto; President, American College of Surgeons, Presiding.

Processional—Officers, Regents, and Honorary Guests.

Invocation.

Address of Welcome. THOMAS E. JONES, M.D., Cleveland; Chairman, Committee on Arrangements.

Introduction of Foreign Guests. ARTHUR W. ALLEN, M.D., Boston; Vice Chairman, Board of Regents.

Representing the Medical Department of the United States Army. Major General JAMES C. MAGEE, Surgeon General, United States Army, Washington.

Representing the Medical Department of the United States Navy. Rear Admiral Ross T. MCINTIRE, Surgeon General, United States Navy, Washington.

Representing the United States Public Health Service. THOMAS PARRAN, M.D., Surgeon General, United States Public Health Service, Washington.

Representing the Office of Civilian Defense. GEORGE BAEHR, M.D., Medical Director (R.), U.S.P.H.S., Chief Medical Officer, United States Office of Civilian Defense, Washington.

Address of the Retiring President: W. EDWARD GALLIE, M.D., Toronto.

Inauguration of Officers:

President: IRVIN ABELL, M.D., Louisville.

First Vice President: LELAND S. MCKITTRICK, M.D., Boston.

Second Vice President: F. PHINIZY CALHOUN, M.D., Atlanta.

Presentation of Initiates for Fellowship. ARTHUR W. ALLEN, M.D., Boston; Vice Chairman, Board of Regents.

Conferring of Fellowships by the President. IRVIN ABELL, M.D., Louisville.

Conferring of Honorary Fellowships. The President.

Medical Records Prize Award. FREDERIC A. BESLEY, M.D., Waukegan, Ill.

FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

Wednesday, Thursday, Friday, 9:00 a.m. to 12:30 p.m.—Music Hall, Public Auditorium

Presentation of the results of clinical and experimental research on problems related to general surgery and the surgical specialties being currently conducted in many of the medical schools, clinics, and hospitals. (See page 529.)

EVENING SESSION

Wednesday, 8:00 p.m.—Music Hall, Public Auditorium

IRVIN ABELL, M.D., Louisville; President, American College of Surgeons, Presiding.

Annual Oration on Surgery: Wounds in Combat. Captain FREDERICK R. HOOK, M.C., U.S.N., Oakland, Calif.

Symposium—Medical Aspects of the War:

Preventive Aspects of Tropical Diseases. Captain CHARLES S. STEPHENSON, M.C., U.S.N., Washington.

The Infectious Disease Problem of the Army. Colonel HUGH J. MORGAN, M.C., U.S.A., Washington.

The Control of Venereal Disease in the Army. Lieutenant Colonel T. B. TURNER, M.C., U.S.A., Washington.

Gynecology and Obstetrics in Their Relation to the War. JAMES R. MILLER, M.D., Hartford, Conn.

CANCER SYMPOSIUM

Thursday, 9:00 a.m.—Room C, Public Auditorium

FRANK E. ADAIR, M.D., New York; Chairman, Cancer Committee, Presiding.

Report of an Experiment to Control Cancer of the Uterus by Means of Periodic Pelvic Examinations. CATHARINE MACFARLANE, M.D., Philadelphia.

Technical Difficulties of Lung Surgery in the Cancer Patient with a Consideration of the Anesthesia Problems. EVARTS A. GRAHAM, M.D., St. Louis.

Amended Cancer Statistics. THOMAS DUFFIELD, Ph.D., New York.

Extending Surgery for Abdominal Carcinoma. ALEXANDER BRUNSCHWIG, M.D., Chicago.

Survey of Problems Connected with Cancer Clinics. Captain CHARLES A. WALTMAN, M.C., U.S.A., Atlanta.

Five-year Cures of Cancer. BOWMAN C. CROWELL, M.D., Chicago.

PANEL DISCUSSIONS

Tuesday, 1:00 p.m.—Music Hall, Public Auditorium

Treatment of Traumatic Shock. ALFRED BLALOCK, M.D., Baltimore, Presiding.

Statement of Problem and Consideration of Early Signs. DALLAS B. PHEMISTER, M.D., Chicago.

Fluid Administration—Quality and Quantity. HENRY N. HARKINS, M.D., Detroit.

Use of Tourniquet, of Heat, and of Cold. ALFRED BLALOCK, M.D., Baltimore.

Anesthesia in Shock. HENRY K. BEECHER, M.D., Boston.

Treatment of Burns. ALFRED BLALOCK, M.D., Baltimore, Presiding.

General Treatment. JONATHAN E. RHOADS, M.D., Philadelphia.

Local Treatment:

Tannic Acid. ROY D. MCCLURE, M.D., Detroit.

Triple Dyes. ROBERT H. ALDRICH, M.D., Boston.

Sulfonamides. LESTER R. DRAGSTEDT, M.D., Chicago.

Some Physical and Chemical Aspects of the Local Treatment of Burns. FRANZ C. SCHMELKES, M.D., Belleville, N. J.

Pressure Dressings. SUMNER L. KOCH, M.D., Chicago.

Early Skin-Grafting. EARL C. PADGETT, M.D., Kansas City, Mo.

Blood and Blood Substitutes. ALFRED BLALOCK, M.D., Baltimore, Presiding.

Whole Blood. MICHAEL E. DEBAKEY, M.D., New Orleans.

Plasma and Serum. ROBERT LOEB, M.D., New York.

Albumin. CHARLES A. JANEWAY, M.D., Boston.
Army and Navy Packages. Lieutenant Commander L. R. NEWHOUSER, M.C., U.S.N., Bethesda, Md.
Other Substitutes. ROBERT ELMAN, M.D., St. Louis.

Combating Chemical Warfare. ALFRED BLALOCK, M.D., Baltimore, Presiding.
Burns. JOHN S. LOCKWOOD, M.D., Philadelphia.
Gas Poisoning; Decontamination Centers. MILTON C. WINTERNITZ, M.D., New Haven, Conn.
The Emergency Treatment of Casualties. Captain EDWARD F. LEWISON, M.C., U.S.A., Edgewood Arsenal, Md.

Wednesday, 1:00 p.m.—Music Hall, Public Auditorium

The Treatment of Wounds. ALLEN O. WHIPPLE, M.D., New York, Presiding.
First-Aid Treatment.
Definitive Treatment. FREDERICK A. COLLER, M.D., Ann Arbor, Mich.
Hospital Treatment, Early and Final. Captain FREDERICK R. HOOK, M.C., U.S.N., Oakland, Calif.; Colonel NORMAN T. KIRK, M.C., U.S.A., Battle Creek, Mich.
Infected Wounds. FRANK L. MELENEY, M.D., New York.
Clean Wounds. MONT R. REID, M.D., Cincinnati.
Urological Injuries. CHARLES C. HIGGINS, M.D., Cleveland.
Abdominal Injuries. ROSCOE R. GRAHAM, M.D., Toronto; ARTHUR W. ALLEN, M.D., Boston.
Injuries to Blood Vessels.
Injuries to Peripheral Nerves. HENRY C. MARBLE, M.D., Boston.

Thursday, 3:00 p.m.—Music Hall, Public Auditorium

Treatment of War Injuries to the Chest. EVARTS A. GRAHAM, M.D., St. Louis, Presiding.
Sucking Wounds and Open Pneumothorax. EVARTS A. GRAHAM, M.D., St. Louis.
Wounds of the Heart. ISAAC A. BIGGER, M.D., Richmond, Va.
Wounds of the Lungs.
Combined Thoracic and Abdominal Wounds. CLAUDE S. BECK, M.D., Cleveland.
Pulmonary Tuberculosis in Soldiers.

Thursday, 4:45 p.m.—Music Hall, Public Auditorium

Anesthesia for War Surgery. RALPH T. KNIGHT, M.D., Minneapolis, Presiding.
Anesthesia Used at Pearl Harbor.
The Place of Intravenous Anesthesia in War Surgery. JOHN S. LUNDY, M.D., Rochester, Minn.
The Place of Spinal and Regional Anesthesia in War Surgery. Major CHARLES F. MCCUSKEY, M.C., U.S.A., San Francisco.
The Place of Inhalation Anesthesia in War Surgery. KENNETH C. MCCARTHY, M.D., Toledo.
Anesthesia for Special Surgery and Special Situations. RALPH T. KNIGHT, M.D., Minneapolis.

Thursday, 8:00 p.m.—Music Hall, Public Auditorium

Lieutenant Colonel ROBERT H. KENNEDY, M.C., U.S.A., Washington, Presiding.
Refrigeration Anesthesia for Surgery of the Extremities, LYMAN W. CROSSMAN, M.D., New York.
Oration on Fractures and Other Traumas: Amputations. Colonel NORMAN T. KIRK, M.C., U.S.A., Battle Creek, Mich.
Panel Discussions on Fractures:
Fractures and Accompanying Injuries of the Hand. Leader: HENRY C. MARBLE, M.D., Boston.
Collaborators: CONDICT W. CUTLER, M.D., New York; J. H. COUCH, M.D., Toronto.
Fractures into the Knee Joint.
Compound Fractures. Leader: WALLACE H. COLE, M.D., St. Paul.
Collaborators: FRASER B. GURD, M.D., Montreal; GUY A. CALDWELL, M.D., New Orleans; Major R. ARNOLD GRISWOLD, M.C., U.S.A., Atlanta.

Friday, 1:00 p.m.—Music Hall, Public Auditorium

Evacuation and Hospitalization of Wounded in Theaters of Operation. Captain JOHN P. OWEN, M.C., U.S.N., Quantico, Va., and Lieutenant Colonel A. L. GORBY, M.C., U.S.A., Washington, Presiding.

Friday, 8:00 p.m.—Ballroom, Public Auditorium

Treatment of War Injuries to the Skull. HOWARD C. NAFFZIGER, M.D., San Francisco, Presiding.

Experimental Study of Penetrating Wounds and Infections of the Brain. COBB PILCHER, M.D., Nashville, Tenn.

Experiences of the Canadians and English with Craniocerebral Injuries. WILLIAM V. CONE, M.D., Montreal.

Compound Depressed Fractures and the Operative Treatment of Penetrating Wounds of the Head. CLAUDE C. COLEMAN, M.D., Richmond; GILBERT HORRAX, M.D., Boston; Commander W. McK. CRAIG, M.C., U.S.N., Bethesda, Md.

Friday, 9:15 p.m.—Ballroom, Public Auditorium

Treatment of War Injuries to the Face. ROBERT H. IVY, M.D., Philadelphia, Presiding.

General Outline of Early and Late Treatment. ROBERT H. IVY, M.D., Philadelphia.

Fractures of Facial Bones, and Injuries Involving Nasal Accessory Sinuses. WILLIAM MILTON ADAMS, M.D., Memphis, Tenn.

Ocular and Orbital Injuries. EDMUND B. SPAETH, M.D., Philadelphia.

Repair of Soft Tissue Injuries to the Face. FERRIS SMITH, M.D., Grand Rapids, Mich.

COMMITTEE MEETINGS

IRVIN ABELL, M.D., Louisville; Chairman, Board of Regents, Presiding.

STATE AND PROVINCIAL JUDICIARY COMMITTEES

Wednesday, 9:30 a.m.—Room C, Public Auditorium

Statement by the Chairman of the Board of Regents.
Selection and Appointment of Judiciary Committees.
Procedure in Dealing with Judiciary Cases.
Types of Cases Referred to the Judiciary Committees.
Discussion by Fellows and Regents of the College.

STATE AND PROVINCIAL EXECUTIVE COMMITTEES

Wednesday, 10:00 a.m.—Room C, Public Auditorium

Statement by the Chairman of the Board of Regents.
War Sessions Held in 1942 and Plans for Meetings in 1943.
Discussion by the Fellows and Regents of the College.

CREDENTIALS COMMITTEES AND COMMITTEES ON APPLICANTS

Wednesday, 10:30 a.m.—Room C, Public Auditorium

Statement by the Chairman of the Board of Regents.
Summary of Work of Credentials Committees and Committees on Applicants, 1942.
Demonstration—Interviewing a Candidate for Fellowship by a Committee on Applicants.
The Junior Candidate.
Discussion by the Fellows and Regents of the College.

OPHTHALMOLOGY AND OTOLARYNGOLOGY

GROUP CLINICAL CONFERENCES

Wednesday, 11:00 a.m.

Perforating Wounds of the Eyeball. THOMAS D. ALLEN, M.D., Chicago, Presiding.
Collaborators: DANIEL P. HORNBOGEN, M.D., Marquette, Mich.; BERNARD J. LARKIN, M.D., Indianapolis; FREDERICK O. SCHWARTZ, M.D., St. Louis; WALTER S. ATKINSON, M.D., Watertown, N. Y.

Prophylaxis and Therapy of the Common Cold. ALBERT C. FURSTENBERG, M.D., Ann Arbor, Mich., Presiding.

Thursday, 11:00 a.m.

Surgery of Orbital Tumors. WILLIAM L. BENEDICT, M.D., Rochester, Minn., Presiding.
Collaborators: WALTER E. DANDY, M.D., Baltimore; J. GRAFTON LOVE, M.D., Rochester, Minn.; DONALD J. LYLE, M.D., Cincinnati.

Management of Acute Respiratory Obstruction Specifically Related to the Larynx and the Tracheobronchial Tree. CHEVALIER L. JACKSON, M.D., Philadelphia, Presiding.

Friday, 11:00 a.m.

Chemical Injuries to the Eye, Including War Gases. CONRAD BERENS, M.D., New York, Presiding.
Collaborator: ELBERT S. SHERMAN, M.D., Newark.

Otitic Complications of Skull Fractures. WILLIAM E. GROVE, M.D., Milwaukee, Wis., Presiding.

PANEL DISCUSSIONS

Wednesday, 8:30 p.m.—Rooms A and B, Public Auditorium

Traumatic Unilateral Lens Injury. DANIEL B. KIRBY, M.D., New York. Presiding.

Treatment of Wounds of the Neck.

Thursday, 8:00 p.m.—Rooms A and B, Public Auditorium

Extra-Ocular Injuries. WILLIAM L. BENEDICT, M.D., Rochester, Minn., Presiding.
Collaborators: HARRY S. GRADLE, M.D., Chicago; ALBERT D. RUEDEMANN, M.D., Cleveland; BRITTAIN F. PAYNE, M.D., New York.

Treatment of Burns of the Face. GORDON B. NEW, M.D., Rochester, Minn., Presiding.
Collaborator: ALFRED W. FARMER, M.D., Toronto.

Friday, 8:00 p.m.—Ballroom, Public Auditorium

Treatment of War Injuries to the Skull. HOWARD C. NAFFZIGER, M.D., San Francisco, Presiding. (See complete program on page 538.)

Treatment of War Injuries to the Face. ROBERT H. IVY, M.D., Philadelphia, Presiding. (See complete program on page 538.)

ASSEMBLY OF INITIATES

Tuesday, 1:00 p.m.—Ballroom, Public Auditorium

W. EDWARD GALLIE, M.D., Toronto; President, Presiding.

Processional—Officers, Regents, and Governors.

Opening Remarks. W. EDWARD GALLIE, M.D., Toronto; President.

The Program of the American College of Surgeons.

The Department of Clinical Research: Cancer; Fractures and Other Traumas; Hall of the Art and Science of Surgery. BOWMAN C. CROWELL, M.D., Chicago; Associate Director.

Hospital Standardization; War Sessions; Graduate Training in Surgery; Library and Department of Literary Research. MALCOLM T. MACEACHERN, M.D., Chicago; Associate Director.

The Fellowship Pledge. Recital by Initiates.

Fellowship in the College. IRVIN ABELL, M.D., Louisville; Chairman, Board of Regents.

Signing of the Fellowship Roll. The Initiates.

Reception by the Officers and Regents for the Initiates and Fellows and members of their families.

ANNUAL MEETING, BOARD OF GOVERNORS

Wednesday, 12:00 M.—Statler Hotel

IRVIN ABELL, M.D., Louisville; President, American College of Surgeons, Presiding.

Statement by the Chairman of the Board of Regents. IRVIN ABELL, M.D., Louisville.

Types of Problems Encountered by the Administrative Board and the Central Committee on Credentials and Methods of Dealing with Them: FREDERIC A. BESLEY, M.D., Waukegan, Secretary; MALCOLM T. MACEACHERN, M.D., Chicago, Chairman, Administrative Board; BOWMAN C. CROWELL, M.D., Chicago, Vice Chairman, Administrative Board.

Discussion by the Governors and Regents.

ADJOURNED MEETING, BOARD OF GOVERNORS

Thursday, 1:30 p.m.—Music Hall, Public Auditorium

Report of Committee on Nominations to the Board of Governors.

ANNUAL MEETING, FELLOWS OF THE COLLEGE

Thursday, 1:45 p.m.—Music Hall, Public Auditorium

IRVIN ABELL, M.D., Louisville; President, American College of Surgeons, Presiding.

Report of Committee on Nominations to the Fellows.

Library and Department of Literary Research. MISS L. MARGUERIETE PRIME, Chicago; Librarian.

Financial Report. DALLAS B. PHEMISTER, M.D., Chicago; Treasurer.

Departmental Reports: (a) Hospital Standardization. (b) Work of Credentials Committees, Committees on Applicants, and Committee on History Reviews. (c) War Sessions. (d) Medical Motion Pictures. (e) Public Relations. MALCOLM T. MACEACHERN, M.D., Chicago; Associate Director.

Graduate Training in Surgery—General Surgery and the Surgical Specialties. DALLAS B. PHEMISTER, M.D., Chicago; Chairman, Committee on Graduate Training in Surgery.

Hall of the Art and Science of Surgery. GEORGE CRILE, M.D., Cleveland; Chairman, Committee on the Hall of the Art and Science of Surgery.

Committee on Cancer. FRANK E. ADAIR, M.D., New York; Chairman.

Committee on Fractures and Other Traumas. Lieutenant-Colonel ROBERT H. KENNEDY, M.C., U.S.A., Washington; Chairman.

Department of Clinical Research. BOWMAN C. CROWELL, M.D., Chicago; Associate Director.

College Administration. FREDERIC A. BESLEY, M.D., Waukegan; Secretary.

Fellowship Obligations and Opportunities. ARTHUR W. ALLEN, M.D., Boston; Vice Chairman, Board of Regents.

The College in Its Relation to the War Program. IRVIN ABELL, M.D., Louisville; Chairman, Board of Regents.

PRELIMINARY CLINICAL PROGRAM

LAKESIDE HOSPITAL

Tuesday

GENERAL SURGERY

Staff—2. Dry clinic: Major factors controlling mortality rate in resections of stomach and bowel.
CARL H. LENHART. Introductory remarks.
HIRAM O. STUDLEY. Percentage weight loss as a basic indicator of surgical risk in patients with chronic peptic ulcer.
EDWARD MUNTWYLER. Basic biochemical considerations with respect to dehydration, salt depletion, acid base balance and hypoproteinemia.
FREDERICK R. MAUTZ. Clinical aspects of dehydration.
WILLIAM E. ABBOTT. Correction of hypoproteinemia by parenteral amino acid.
FRANK M. BARRY. Results obtained by Lakeside house-officers in resections of the stomach and colon over the past year.

OPHTHALMOLOGY

A. B. BRUNER—2. Conference and discussion: Malingering and its diseases.
M. P. MOTTO—3:30. Conference: Strabismus, practical surgical points.

Wednesday

GENERAL SURGERY

JOHN W. HOLLOWAY, RUSSELL H. BIRGE, FRANK S. GIBSON, and FRANK M. BARRY—9. Operative clinic.
CLAUDE S. BECK—9. Heart operation.
Staff—2. Dry clinic:
HARRY GOLDBLATT. Hypertension: Experimental observations on the present status of surgical treatment.
PAUL J. SCHILDT. Unilateral kidney disease, causing hypertension.
JOHN E. WILLIAMS. Pheochromocytoma of adrenal gland, causing hypertension; undescended testicle, results of operation; exhibit of pyelograms.

GENITOURINARY SURGERY

JOHN E. WILLIAMS, PAUL J. SCHILDT, and JAMES J. LYNCH—9. Operative clinic.

OPHTHALMOLOGY

M. P. MOTTO—9. Operative clinic.

Thursday

GENERAL SURGERY

HARRY G. SLOAN, ERNEST F. BRIGHT, ROBERT M. HOSLER, WILLIAM D. HOLDEN, and EDWARD P. JUDD—9. Operative clinic.
CLAUDE S. BECK—2. Dry clinic: Surgical lesions of the heart, demonstration of patients, illustrating various surgical topics.

ORTHOPEDIC SURGERY

MAXWELL HARBIN, CLARENCE H. HEYMAN, and JOHN A. MURPHY—9. Operative clinic.

THORACIC SURGERY

S. O. FREEDLANDER—9. Operative clinic.

OPHTHALMOLOGY

L. V. JOHNSON and MR. ECKER—9. Conference and demonstration: Riboflavin and its uses in ophthalmology.

Friday

GENERAL SURGERY

CARL H. LENHART, FREDERICK R. MAUTZ, and FRANK S. GIBSON—9. Operative clinic.
CLAUDE S. BECK—9. Heart operation.

GENITOURINARY SURGERY

THOMAS P. SHUPE—9. Operative clinic.

OPHTHALMOLOGY

C. I. THOMAS—9. Operative clinic.

MATERNITY HOSPITAL

Wednesday

OBSTETRICS AND GYNECOLOGY

A. H. BILL, W. H. WEIR, W. R. BARNEY, R. L. FAULKNER, F. S. MOWRY, and J. L. REYCRAFT—9. Operative and dry clinic.
A. H. BILL, W. H. WEIR, W. R. BARNEY, R. L. FAULKNER, F. S. MOWRY, and J. L. REYCRAFT—2. Dry clinic.

Thursday

OBSTETRICS AND GYNECOLOGY

A. H. BILL, W. H. WEIR, W. R. BARNEY, R. L. FAULKNER, F. S. MOWRY, and J. L. REYCRAFT—9. Operative and dry clinic.
A. H. BILL, W. H. WEIR, W. R. BARNEY, R. L. FAULKNER, F. S. MOWRY, and J. L. REYCRAFT—2. Dry clinic.

Friday

OBSTETRICS AND GYNECOLOGY

A. H. BILL, W. H. WEIR, W. R. BARNEY, R. L. FAULKNER, F. S. MOWRY, and J. L. REYCRAFT—9. Operative and dry clinic.

UNITED STATES MARINE HOSPITAL

Wednesday

GENERAL SURGERY

S. A. DEMARTINI and staff—9. Operations.

Thursday

GENERAL SURGERY

W. S. MOZDEN—1. Dry clinic: Varicose veins, ligations and obliterative treatment.
C. H. DUSTON—1. Dry clinic: Spinal anesthesia.
CARL ENNA—1. Dry clinic: Postoperative pulmonary complications; demonstration of plasma bank operation.

OPHTHALMOLOGY

M. E. GANS—9. Dry clinic: Eyeground demonstrations.

Friday

GENERAL SURGERY

S. A. DEMARTINI and staff—9. Operations.

CLEVELAND CLINIC HOSPITAL

Tuesday

GENERAL SURGERY

ROBERT S. DINSMORE—2. Operations.

GENITOURINARY SURGERY

WILLIAM E. LOWER and CHARLES C. HIGGINS—2. Operations.

NEUROSURGERY

W. A. NOSIK—2. Operations.

OTOLARYNGOLOGY

HAROLD E. HARRIS—2. Operations.
Staff—2. Dry clinic: Nasal plastic.

Wednesday

GENERAL SURGERY

THOMAS E. JONES—9. Operative clinic.
Staff—9. Dry clinic:
W. A. NOSIK—9. Abdominal pain of neurological origin.
CHARLES C. HIGGINS—9:15. Renal calculi management.
ALLAN GRAHAM—9:30. Prognosis of malignant tumors.
Staff—10:10. Symposium: Spleen.
RUSSELL L. HADEN—10:25. Indications and contraindications for splenectomy.
ROBERT S. DINSMORE—10:45. Surgical problems in splenectomy.
B. H. NICHOLS—11:10. Ulcer, atypical lesion about the pylorus.
R. J. F. RENSHAW—11:30. Experiences in 900 gastroscopies.
E. N. COLLINS—11:50. Indications for surgery in gastric and duodenal ulcer.
ROBERT S. DINSMORE—2. Operations.

GENITOURINARY SURGERY

WILLIAM E. LOWER and CHARLES C. HIGGINS—2. Operative clinic.

ORTHOPEDIC SURGERY

J. A. DICKSON and J. I. KENDRICK—9. Operative clinic.

NEUROSURGERY

A. T. BUNTS—9. Operative clinic.
W. A. NOSIK—2. Dry clinic.

OPHTHALMOLOGY

A. D. RUEDEMANN—9. Operative clinic.
PAUL G. MOORE—10:30. Dry clinic.
A. D. RUEDEMANN—2. Conference on exophthalmus.

OTOLARYNGOLOGY

Staff—9. Operative clinic.
HAROLD E. HARRIS—2. Operative clinic.

Thursday

GENERAL SURGERY

THOMAS E. JONES—9. Operative clinic.
ROBERT S. DINSMORE and F. L. SHIVELY—2. Operative clinic.

FRACTURES AND OTHER TRAUMAS

J. A. DICKSON and J. I. KENDRICK—9. Operations.

GENITOURINARY SURGERY

WILLIAM E. LOWER and CHARLES C. HIGGINS—2. Dry clinic, motion pictures.

NEUROSURGERY

A. T. BUNTS—9. Operative clinic.
W. A. NOSIK—2. Operative clinic.

OPHTHALMOLOGY

A. D. RUEDEMANN—9. Operative clinic.
PAUL G. MOORE—9. Operative clinic.
A. D. RUEDEMANN—2. Dry clinic: Allergy in ophthalmology.

OTOLARYNGOLOGY

HAROLD E. HARRIS—2. Operative clinic.

Friday

GENERAL SURGERY

THOMAS E. JONES—9. Operative clinic.

ORTHOPEDIC SURGERY

J. A. DICKSON and J. I. KENDRICK—9. Operative clinic.

NEUROSURGERY

A. T. BUNTS—9. Operative clinic.

OPHTHALMOLOGY

A. D. RUEDEMANN—9. Dry clinic: Exophthalmology.
PAUL G. MOORE—9. Operative clinic.

LAKEWOOD HOSPITAL

Tuesday

OBSTETRICS AND GYNECOLOGY

R. A. PEASE—2. Dry clinic: Problems of the newborn, impetigo and other skin lesions.

OTOLARYNGOLOGY

Staff—2. Dry clinic: Peroral endoscopy; vertigo due to eustachian tube obstruction and its treatment.

Wednesday

GENERAL SURGERY

C. LEE GRABER and associates—9. Operative clinic.
C. LEE GRABER—2. Dry clinic: Improved and simplified technique for intravenous medication.

ORTHOPEDIC SURGERY

LOUIS M. STARIN—9. Operative and dry clinic.

OTOLARYNGOLOGY

FORREST W. MERICA—2. Dry clinic: Vertigo due to eustachian tube obstruction and its treatment.

Thursday

GENERAL SURGERY

NORTH W. SHETTER—9. Exhibit of interesting x-ray cases, discussion of radiological problems.
STANLEY N. P. DEVILLE and G. C. RANKIN—9. Demonstration of technique for spinal anesthesia.

GENITOURINARY SURGERY

L. F. HUFFMAN—2. Urological demonstrations.

OTOLARYNGOLOGY

RALPH W. FRACKELTON—9. Operations: Nasal plastic.
Staff—2. Dry clinic: Peroral endoscopy.

CITY HOSPITAL

Tuesday

GENERAL SURGERY

L. A. POMEROY, H. H. HAUSER, S. O. FREEDLANDER, and associates—2. Tumor clinic.

H. T. KARSNER, H. Z. LUND, and associates—2. Clinical pathological conference.

Wednesday

GENERAL SURGERY

S. O. FREEDLANDER, M. B. TALIAK, R. J. MCNAMEE, M. H. LAMBRIGHT, and A. M. LEIGH—9. Operative clinic: Gastric resection, cholecystectomy, thyroidectomy, radical mastectomy.

Staff—2. Medical and surgical clinic with case presentations and discussion:

R. W. SCOTT. Thyroid and heart disease.
E. E. BEARD. Hyperparathyroidism.
M. L. SIEGEL. Jaundice.
H. H. HAUSER. Treatment of tuberculous lymph nodes by irradiation.
Z. T. WIRTSCHAFTER. Bleeding peptic ulcer.
R. C. MCKAY. Pulmonary sarcoidosis.

GENITOURINARY SURGERY

H. R. TRATTNER and associates—9. Operative clinic: Radical operation for carcinoma of the prostate, perineal prostatectomy, nephrectomy, prostatic injection through partition catheter.

THORACIC SURGERY

Staff—1:30. Chest conference:

S. O. FREEDLANDER, R. C. MCKAY, H. H. HAUSER, and associates—1:30. Selection of cases for medical, surgical and radiological treatment.

S. O. FREEDLANDER and associates—3:10. End-results of chest surgery.

OPHTHALMOLOGY

PAUL G. MOORE—9. Dry clinic: Demonstration of cases.

Thursday

GENERAL SURGERY

L. A. ATLAS and associates—9. Operative clinic: Leg amputation, thoracic sympathectomy, lumbar sympathectomy, saphenous vein ligation.

S. O. FREEDLANDER, M. B. TALIAK, R. J. MCNAMEE, and staff—2. Dry clinic: Head, neck, chest, abdomen, extremities, burns.

L. A. ATLAS and staff—2. Dry clinic: Diagnosis and treatment of peripheral vascular diseases, lantern slides and case demonstrations.

ORTHOPEDIC SURGERY

G. I. BAUMAN, L. M. STARIN, R. S. REICH, and associates—9. Operative clinic: Spinal fusion, repair of ruptured meniscus.

G. I. BAUMAN, L. M. STARIN, R. S. REICH, and associates—2. Dry clinic.

OTOLARYNGOLOGY

Staff—2. Dry clinic: Demonstration of cases of oral and laryngeal malignancies.

Friday

OBSTETRICS AND GYNECOLOGY

J. L. REYCRAFT and associates—9. Operative clinic: Watkins' interposition and perineorrhaphy, vaginal plastic and panhysterectomy, supracervical hysterectomy.

THORACIC SURGERY

S. O. FREEDLANDER and M. H. LAMBRIGHT—9. Operative clinic: Lobectomy, pneumonectomy, thoracoplasty.

OPHTHALMOLOGY

G. LESLIE MILLER—9. Dry clinic: Demonstration of cases.

ST. VINCENT'S CHARITY HOSPITAL

Tuesday

OPHTHALMOLOGY

HOWARD SHIRAS and associates—2. Demonstration of cases.

Wednesday

GENERAL SURGERY

O. A. WEBER, E. P. NEARY, and W. H. ODELL—9. Operations.

ORTHOPEDIC SURGERY

C. G. BARBER—9. Operative clinic.

OPHTHALMOLOGY

HOWARD SHIRAS and associates—2. Demonstration of cases.

OTOLARYNGOLOGY

Staff—2. Operative clinic.

Thursday

GENERAL SURGERY

E. P. NEARY, J. E. HALLISY, and J. G. BRADY—9. Operative clinic.

Friday

GENERAL SURGERY

J. E. HALLISY, H. C. NASH, and J. G. BRADY—9. Operative clinic.

GENITOURINARY SURGERY

H. R. TRATTNER and L. F. HUFFMAN—9. Operative clinic.

EVANGELICAL DEACONESS HOSPITAL

Wednesday

GENERAL SURGERY

J. R. JOHNSON, J. H. BUDD, and M. B. TALIAK—9. Operative and dry clinic.

Thursday

GENERAL SURGERY

O. A. WEBER and J. H. BUDD—9. Operative and dry clinic.

Friday

GENERAL SURGERY

J. R. JOHNSON, J. H. BUDD, and M. B. TALIAK—9. Operative and dry clinic.

HURON ROAD HOSPITAL

Tuesday

GENERAL SURGERY

ROSWELL LOWRY—2. Lecture and demonstration: Ultraviolet blood irradiation therapy.
R. J. WHITACRE, B. B. SANKEY, J. K. POTTER, and A. J. FISHER—2. Dry clinic: Recent advances in anesthesia.

OBSTETRICS AND GYNECOLOGY

A. G. CUMMINGS, G. H. IRVIN, JR., and staff—2. Operations: Obstetrical.

Wednesday

GENERAL SURGERY

T. S. JACKSON and G. M. HAWK—9. Operations: Thyroidectomies and mastectomies.
R. J. WHITACRE, B. B. SANKEY, J. K. POTTER, and A. J. FISHER—9. Dry clinic: Methods in anesthesia.
EDWARD GOODSITT—2. Operation of blood bank in a general hospital.

OBSTETRICS AND GYNECOLOGY

H. K. DIMLICH—9. Operations: Gynecological; peritoneoscopy.
A. G. CUMMINGS, G. H. IRVIN, JR., and staff—2. Operations: Obstetrical.

ORTHOPEDIC SURGERY

A. H. REED and staff—9. Operative clinic: Orthopedics and fractures.

GENITOURINARY SURGERY

V. C. LAUGHLIN—2. Dry clinic: Pyelograms and their interpretation.

OTOLARYNGOLOGY

G. H. QUAY—9. Operations: Harelip and mastoid.

Thursday

GENERAL SURGERY

R. R. RENNER, D. H. PATTERSON, and C. C. PERRY—9. Operative clinic: Rectal, gastrectomies, intestinal resections.
R. J. WHITACRE, B. B. SANKEY, J. K. POTTER, and A. J. FISHER—9. Dry clinic: Methods in anesthesia.

OBSTETRICS AND GYNECOLOGY

G. J. SALISBURY—9. Operations: Vaginal hysterectomies.
A. G. CUMMINGS, G. H. IRVIN, JR., and staff—2. Operations: Obstetrical.

ORTHOPEDIC SURGERY

A. H. REED—2. Dry clinic.

GENITOURINARY SURGERY

V. C. LAUGHLIN—9. Operations: Prostate and kidney.

OTOLARYNGOLOGY

M. F. METZENBAUM—9. Operations: Nasal plastic.

Friday

GENERAL SURGERY

T. S. JACKSON—9. Operations: Cholecystectomies.
A. E. BIDDINGER, B. B. KIMMEL, T. L. LAUGHLIN, JR., and L. L. CHANDLER—9. Operative clinic.
R. J. WHITACRE, B. B. SANKEY, J. K. POTTER, and A. J. FISHER—9. Dry clinic: Methods in anesthesia.

OPHTHALMOLOGY

WILLIAM H. PHILLIPS, JOSEPHINE DIRION PHILLIPS, and C. I. THOMAS—9. Operations.

OTOLARYNGOLOGY

Staff—9. Operative clinic: Selective anesthesia in tonsil operations.

FAIRVIEW PARK HOSPITAL

Tuesday

OBSTETRICS AND GYNECOLOGY

E. D. SAUNDERS and T. M. WILLE—2. Operative clinic.

Wednesday

GENERAL SURGERY

H. W. MASENHIMER and J. R. KELKER—9. Operative clinic.

GENITOURINARY SURGERY

L. F. HUFFMAN—2. Operative clinic.

Thursday

GENERAL SURGERY

W. E. SMITH and F. H. J. HEYSE—9. Operative clinic.

OBSTETRICS AND GYNECOLOGY

E. D. SAUNDERS and T. M. WILLE—2. Dry clinic.

ORTHOPEDIC SURGERY

G. I. BAUMAN—9. Operative clinic.

Friday

GENERAL SURGERY

H. W. MASENHIMER, F. H. J. HEYSE, W. E. SMITH, and J. R. KELKER—9. Operative clinic.

LUTHERAN HOSPITAL

Tuesday

GENERAL SURGERY

Staff—2. Surgical conference.

Wednesday

GENERAL SURGERY

HARRY G. SLOAN—9. Operative clinic.
Staff—2. Surgical conference.

GENITOURINARY SURGERY

THOMAS P. SHUPE—2. Operative clinic.

Thursday

GENERAL SURGERY

FRANK S. GIBSON and JOHN BOHM—9. Operative clinic.
Staff—2. Surgical conference.

Friday

GENERAL SURGERY

DWIGHT S. SPRENG—9. Operative clinic.

OPHTHALMOLOGY

JAMES T. COLLINS—9. Operative clinic.

OTOLARYNGOLOGY

JAMES T. COLLINS—9. Operative clinic.

MOUNT SINAI HOSPITAL

Wednesday

GENERAL SURGERY

ABRAHAM STRAUSS and staff—9. Operative clinic.
B. S. KLINE and members of the departments of medicine and surgery—10:30. Symposium: Allergy and its relation to surgery.

OBSTETRICS AND GYNECOLOGY

J. L. BUBIS, M. E. GARBER, and staff—9. Operative clinic.
M. E. GARBER and ANNA YOUNG—2. Dry clinic: Endometriosis, its clinical and pathological aspects.
J. L. BUBIS—2. Dry clinic: Puerperal gynecology, results of 25 years' practice.

ORTHOPEDIC SURGERY

R. S. REICH—10:30. Dry clinic: Treatment of ununited fracture of neck of femur; comminuted fracture of calcaneous, recent and old; treatment of compression fracture of spine, with special emphasis on late reduction.

GENITOURINARY SURGERY

P. A. JACOBS and staff—9. Dry clinic.

OPHTHALMOLOGY

M. E. GANS and associates—9. Demonstration of eye cases.

Thursday

GENERAL SURGERY

ABRAHAM STRAUSS and staff—9. Operative clinic.
S. S. QUITTNER and S. BAUMOEL—9. Dry clinic: Vertigo.
B. S. KLINE and members of the departments of medicine and surgery—10:30. Symposium: Allergy and its relation to surgery.

OBSTETRICS AND GYNECOLOGY

J. L. BUBIS, M. E. GARBER, and staff—9. Operations: Gynecological.

ORTHOPEDIC SURGERY

R. S. REICH and staff—9. Operative clinic.

GENITOURINARY SURGERY

P. A. JACOBS—9. Operative clinic.

OTOLARYNGOLOGY

Staff—9. Dry clinic.

Friday

GENERAL SURGERY

ABRAHAM STRAUSS and staff—9. Operative clinic.
ABRAHAM STRAUSS—10:30. Dry clinic: Undescended testes presentation of cases.
B. S. KLINE—11. Pathological conference, current surgical case.

OBSTETRICS AND GYNECOLOGY

M. E. GARBER and J. L. BUBIS—9. Operations.

ORTHOPEDIC SURGERY

R. S. REICH—11. Dry clinic: Treatment of ununited fracture of neck of femur; comminuted fracture of calcaneous, recent and old; treatment of compression fracture of spine, with special emphasis on late reduction.

ST. LUKE'S HOSPITAL

Tuesday

GENERAL SURGERY

Staff—2. Motion pictures: Discussions in general surgery, gynecology, obstetrics, plastic surgery, burns, head surgery, traumatic surgery, orthopedic surgery, genitourinary surgery, and neurosurgery.

Wednesday

GENERAL SURGERY

Staff—9. Operations: General surgery and surgical specialties.
Staff—2. Motion pictures: Discussions in general surgery, gynecology, obstetrics, plastic surgery, burns, head surgery, traumatic surgery, orthopedic surgery, genitourinary surgery, and neurosurgery.

OPHTHALMOLOGY

M. W. JACOBY and associates—9. Demonstration of cases.

OTOLARYNGOLOGY

Staff—9. Operative and dry clinic: Trans-antral ethmoid operation; bronchoscopic cases.

Thursday

GENERAL SURGERY

Staff—9. Operations: General surgery and surgical specialties.
Staff—2. Motion pictures: Discussions in general surgery, gynecology, obstetrics, plastic surgery, burns, head surgery, traumatic surgery, orthopedic surgery, genitourinary surgery, and neurosurgery.

OPHTHALMOLOGY

M. W. JACOBY and associates—9. Demonstration of cases.

OTOLARYNGOLOGY

Staff—9. Operative and dry clinic: Laryngectomy, voice production and motion pictures.

Friday

GENERAL SURGERY

Staff—9. Operations: General surgery and surgical specialties.

OPHTHALMOLOGY

M. W. JACOBY and associates—9. Demonstration of cases.

OTOLARYNGOLOGY

Staff—9. Hearing tests.

WESTERN RESERVE UNIVERSITY SCHOOL OF MEDICINE

Wednesday

OTOLARYNGOLOGY

Staff—2. Demonstration and scientific exhibit of anatomical specimens; pneumatization of temporal bone.

Thursday

OTOLARYNGOLOGY

Staff—2. Demonstration and scientific exhibit of anatomical specimens; pneumatization of temporal bone.

ST. ALEXIS HOSPITAL

Wednesday

GENERAL SURGERY

J. F. CORRIGAN, E. F. KIEGER, E. A. MASTICS, F. A. SPITTLER, and J. N. WYCHGEL—9. Operative clinic.

GENITOURINARY SURGERY

J. A. SOMMER—9. Operative clinic.

NEUROSURGERY

SPENCER BRADEN—9. Operative clinic.

OPHTHALMOLOGY

C. L. MCDONALD—9. Operative clinic.
H. V. PHELAN—10. Demonstration of cases.

OTOLARYNGOLOGY

F. W. DIXON and FRED ADELSTEIN—9. Operative clinic.

Thursday

GENERAL SURGERY

J. F. CORRIGAN, E. F. KIEGER, E. A. MASTICS, F. A. SPITTLER, and J. N. WYCHGEL—9. Operative clinic.

ORTHOPEDIC SURGERY

T. A. WILLIS—9. Operative clinic.

GENITOURINARY SURGERY

J. A. SOMMER—9. Operative clinic.

OPTHALMOLOGY

H. V. PHELAN—9. Operative clinic.

Friday

GENERAL SURGERY

J. F. CORRIGAN, E. F. KIEGER, E. A. MASTICS, F. A. SPITTLER, and J. N. WYCHGEL—9. Operative clinic.

GENITOURINARY SURGERY

J. A. SOMMER—9. Operative clinic.

NEUROSURGERY

SPENCER BRADEN—9. Operative clinic.

OPHTHALMOLOGY

C. L. MCDONALD—9. Operative clinic.

OTOLARYNGOLOGY

F. W. DIXON and FRED ADELSTEIN—9. Operative clinic.

POLYCLINIC HOSPITAL

Wednesday

GENERAL SURGERY

PAUL SPURNEY, H. A. SCHLINK, JOHN T. VITKUS, JOHN R. PLENT, and HENRY M. SCHUR—9. Operations.

Thursday

GENERAL SURGERY

PAUL SPURNEY, H. A. SCHLINK, JOHN T. VITKUS, JOHN R. PLENT, and HENRY M. SCHUR—9. Operations.

ST. JOHN'S HOSPITAL

Tuesday

GENERAL SURGERY

DAVID STEEL—2. Dry clinic: Tumors of the breast.

Wednesday

GENERAL SURGERY

JOHN HANNIBAL, F. T. GALLAGHER, RAYMOND J. SCHRAFF, and J. R. RIPTON—9. Operations.

FRACTURES AND OTHER TRAUMAS

RAYMOND J. SCHRAFF and J. R. RIPTON—2. Dry clinic.

OTOLARYNGOLOGY

C. L. MCDONALD and J. T. COLLINS—9. Operations.

Thursday

GENERAL SURGERY

JOHN HANNIBAL, F. T. GALLAGHER, RAYMOND J. SCHRAFF, and J. R. RIPTON—9. Operations.

GENITOURINARY SURGERY

J. B. MORGAN, W. J. MANNING, and J. A. SOMMER—9. Operations.

OTOLARYNGOLOGY

JAMES T. COLLINS—2. Dry clinic.

Friday

GENERAL SURGERY

JOHN HANNIBAL and F. T. GALLAGHER—9. Operations.

OBSTETRICS AND GYNECOLOGY

Staff—9. Operations.

GRACE HOSPITAL

Tuesday

OBSTETRICS AND GYNECOLOGY

PAUL F. HASSE—2. Operative and dry clinic: Gynecological.

OPHTHALMOLOGY

H. W. COOPER—2. Operative and dry clinic.

OTOLARYNGOLOGY

H. W. COOPER—2. Operative and dry clinic.

Wednesday

GENERAL SURGERY

HARRY C. BARR—9. Operative and dry clinic: Rectal.
L. J. STERNICKI—2. Operative and dry clinic.

Thursday

GENERAL SURGERY

F. P. GERACI—9. Operative and dry clinic.
A. E. BIDDINGER—2. Operative and dry clinic.
H. H. HAUSER—2. X-ray demonstration.
W. P. JENNINGS—3:30. Pathological demonstration.

Friday

GENERAL SURGERY

S. M. ADAMS and C. B. MILLER—9. Operative and dry clinic.